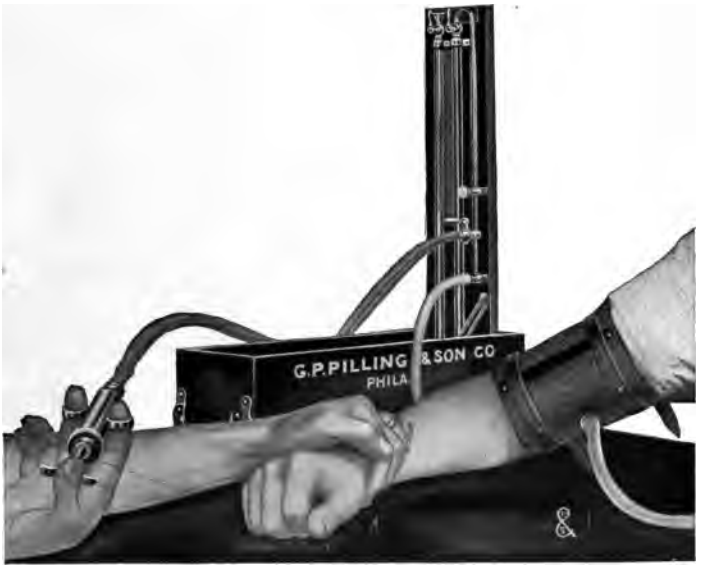
BLOOD-PRESSURE PRIMER

THE SPHYGMOMANOMETER

AND ITS PRACTICAL APPLICATION

By F. A. FAUGHT

FOURTH EDITION



Standard Mercury Sphygmomanometer in use.

D-PRESSURE PRIMER

THE
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ND ITS PRACTICAL APPLICATION

'LL DESCRIPTION OF THE SEVERAL NEW INSTRUMENTS
AND PRACTICAL INFORMATION PERTAINING TO
CLINICAL SPHYGMOMANOMETRY

BY

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'ining One Full-page Plate and Numerous Explanatory Diagrams in the Text

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CHAPTER I.

THE CIRCULATION.

The application of instruments of precision for the study of conditions of the circulation marks an epoch in the history of medicine. The application of scientific instruments in clinical medicine has developed a large amount of valuable information concerning the relation of the heart, blood-vessels and kidneys, in both normal and pathologic conditions. We are now able by means of easily applied tests to gather accurately and quickly an enormous amount of detailed information which could have been found by no other means.

Instruments of Precision.

This general increase in knowledge of special diseases has placed an added amount of responsibility upon the medical profession, for the public has so learned to appreciate the benefit to be derived from this broader knowledge, that patients now demand special methods of examination and study, in every case, far greater than was ever dreamed of twenty years ago.

Among the many scientific instruments now employed in the study and practice of medicine, there is probably not one single instrument of greater use and of easier application than the sphygmomanometer. Its value has now become so fully established that it needs no argument to show an intelligent physician that the sphygmomanometer is a most important part of his armamentarium.

Importance of Sphygmomanometry.

In taking up this discussion of blood-pressure apparatus and blood-pressure tests, it is only necessary to call attention to the fact that the normal circulation is a vital function necessary in the maintenance of health and that the cardio-vascular system is involved to a more or less degree in the great majority of diseased conditions. It is evident that the knowledge of the

condition of the heart and circulation plays an important part, not only in diagnosis, but in prognosis and in treatment.

In taking up the consideration of the subject of blood-pressure, a brief review of the physiology of the circulation is essential in order that departures from it may be recognized and that these changes may be given their proper value in the general symptom-complex.

Roughly speaking, the heart and arteries may be likened to a force pump and series of elastic tubes which supply every part of the body with nutrition, remove waste products and at the same time contribute to the size and density of the organs. The heart is a compound pump of intermittent action. From this springs the aorta which rapidly ramifies from the heart to the periphery. The aorta receives blood from the heart in intermittent jets, and this would be transmitted to the periphery in the same intermittent manner, were it not for the elasticity and other vital properties of the blood-vessel walls.

Physiology of Circulation.

The mechanism of the circulation is largely concerned in reducing this intermittent stream to the continuous flow found in the organs and capillaries. It is also concerned in maintaining the proper supply of blood to each part as the demand may arise for increased nutrition. In order to accomplish this function, it is essential that the blood should be maintained under a certain degree of pressure. This is necessary to insure the proper distribution and have an increased supply in any particular region when demanded. This relation is maintained by what is known as blood-pressure.

Arterial Pressure.

Normal blood-pressure depends upon the normal correlation and interaction of certain variable factors: (1) The amount of blood pumped into the arterial system by the heart. (2) The resistance offered to the escape of blood toward the periphery through the smaller arteries and

Cause of Normal Blood-Pressure.

the capillaries. Of less importance are (3) the elasticity of the vessel walls, (4) the total quantity of blood in the body, and (5) viscosity. These factors are all capable of interaction in the most complicated manner. For example, if the arterial pressure is increased from any cause, the vagus nerve is stimulated, and the effect of its inhibitory action upon the heart is to lower the heart rate so that less blood is delivered into the aorta in a given time, thus assisting to maintain normal blood-pressure. In like manner, when the volume of blood is rapidly reduced from hemorrhage or venesection, the blood-vessel reflex immediately reduces the calibre of the arteries, so that within certain limits the blood-pressure is not altered.

CHAPTER II.

TERMS AND DEFINITIONS.

Having briefly reviewed the physiology of the normal circulation and the causes concerned in the production and maintenance of blood-pressure, we may now proceed to a consideration of the relation of these facts to the problems of clinical medicine and their bearing on Diagnosis, Prognosis and Treatment.

To obtain a clear insight and understanding of the subject it is all-important to have an accurate knowledge of the terms applied to the matter under consideration.

The Pulse.—The pulse is a rhythmically recurring impulse arising in the systole of the left ventricle, and palpable through the arterial system. Its presence indicates a variation in blood-tension within the arteries, which causes them to pulsate, as the walls momentarily expand.

Blood-pressure.—Blood-pressure is the term employed to indicate the degree of pressure under which the blood exists while traversing the arteries. Unless otherwise specified, the term blood-pressure as used throughout this book indicates arterial systolic blood-pressure.

Systolic Blood-pressure. — Systolic blood-pressure means the degree of arterial pressure or lateral tension existing in the arterial system at the moment of cardiac systole.

Diastolic Blood-pressure.—Diastolic blood-pressure means the degree of arterial pressure or lateral tension existing in the blood-vessels just preceding a systole of the heart. This represents the time when the blood-pressure is at its lowest.

Pulse-pressure, Rate or Amplitude.—These synonymous terms indicate the amount of periodic variation in blood-pressure occurring within the arterial system, due to the intermittent action of the heart. It is equal to the difference between systolic and diastolic blood-pressures as determined by the sphygmomanometer.

Mean Tension.—Mean tension is the term applied

to indicate the average strain to which the arterial system is subjected. It corresponds closely to the arithmetical mean of the systolic and diastolic blood-pressure. The relation between these several terms and normal pulse tracing is shown in Fig. 1.

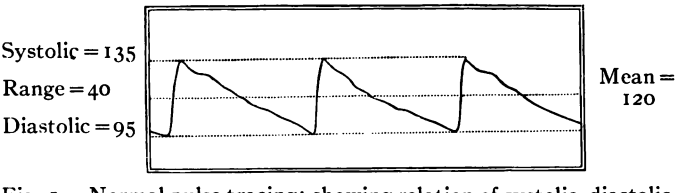


Fig. 1.—Normal pulse tracing: showing relation of systolic, diastolic, pulse pressure and mean. Pulse pressure equals 40.

Normal Tension.—This term applies to the systolic blood-pressure which should be found in a normal individual as determined by the study of a large number of persons. This pressure is modified by a number of normal or physiological conditions, and is therefore subjected to some variation. Full discussion of these will be taken up in Chapter III, page 33.

Hypotension.—Hypotension is the term applied to the condition of the circulation in which the systolic blood-pressure is found to be below the normal as estimated for the individual.

Hypertension.—Hypertension is the term applied to a condition of the blood-pressure when the level is maintained above the estimated minimum normal pressure.

CHAPTER III.

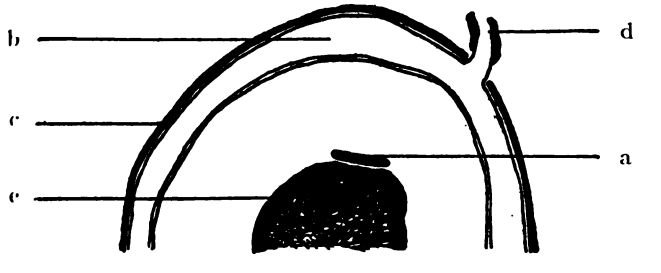
THE SPHYGMOMANOMETER.

The Principle of the Sphygmomanometer.

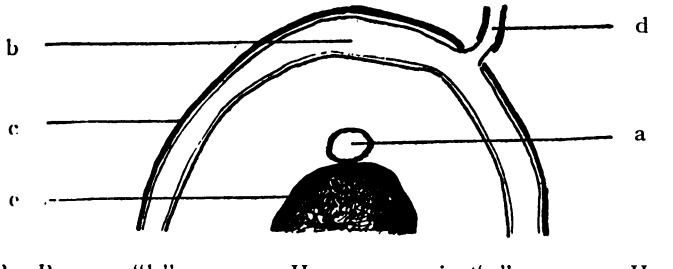
The Mechanical Principle.

Vital tissue is perfectly elastic. Therefore any pressure applied to the surface of the body will be directly transmitted to the underlying structures without loss of force. It is upon this principle that the indirect method of measuring the blood-pressure is based.

Pressure is applied to an accessible part of the body over a large blood-vessel, such as the brachial. If the



A. Pressure in "b" 135 mm. Hg.; pressure in "a" 130 mm. Hg. B is therefore collapsed, pulse cannot pass.



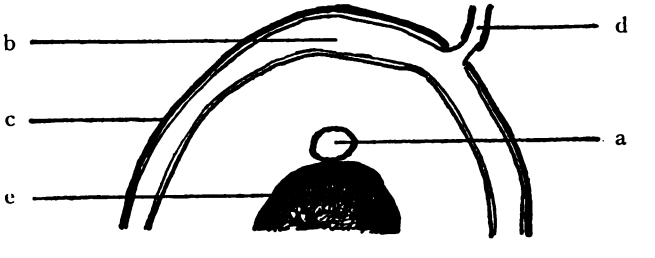
B.—Pressure "b" 129 mm. Hg.; pressure in "a" 130 mm. Hg. Pulse passes.

FIG. 2.—Diagram of relations of armlet to brachial artery. Explanation of systolic reading: a, artery; b, compressing armlet; c, retaining cuff; d, tube to manometer; e, humerus.

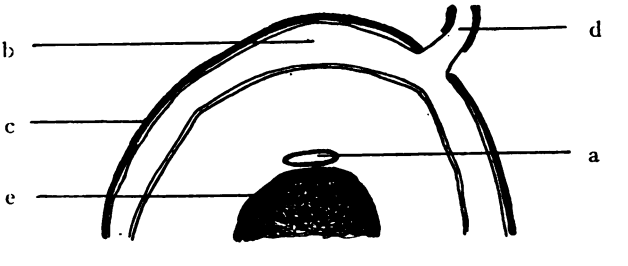
amount of this pressure is sufficient to overcome the pressure of the blood within the vessel, the vessel will be collapsed and the pulse prevented from passing beyond it. If the amount of the compressing force is measured and expressed in definite terms of weight (as millimeters of a column of mercury) then we can, by applying just sufficient pressure to collapse the vessel, measure the amount of force exerted by the blood in preventing this collapse.

Circular Compression.

In practice the pressure is produced by a cautery bulb or a small hand pump, and applied to the arm by means of a hollow flat rubber bag. This is applied about the arm and held there by some form of inelastic cuff. Communication with a suitable manometer measures the amount of pressure applied to the vessel.



A.—Systolic pressure in "a" 130 mm. Hg.; pressure in "b" 101 mm. Hg. Artery not compressed.



B.—Diastolic pressure in "a" 100 mm. Hg.; pressure in "b" 101 mm. Hg. Artery collapsed.

FIG. 3.—Diagram of relation of armlet to brachial artery. Explanation of diastolic reading: a, artery; b, compressing armlet; c, retaining cuff; d, tube to manometer; e, humerus.

Fig. 2, A and B, shows the relation of the compressing bag to the artery. In Fig. 2, A, the pressure within the cuff is greater than the blood-pressure within the artery, which is therefore collapsed and the pulse in the distal end of the vessel cut off. In Fig. 2, B, the pressure in the cuff has been reduced so that it is a fraction of a millimeter less than the systolic pressure within the vessel. Now at each systole a small amount of blood will pass the constriction and will reach the distal end of the artery, where the wave can be felt by the palpating finger at the wrist.

Explanation of Systolic Reading.

Fig. 3, A and B, represents the conditions existing between the constricting cuff and the vessel at the diastolic time of pressure. A represents a pressure within the cuff less than the systolic pressure in the vessel. This is insufficient to affect the vessel during the systolic period. B shows the artery and cuff during the diastolic period, when the pressure within the artery is at its lowest point, a fraction of a millimeter less than the pressure within the cuff. Consequently the artery is collapsed at this time. The effect of each succeeding systole is to alternate between a round and a flat vessel at the point of compression. This affects the pressure of the air within the cuff, which is in turn transmitted to the mercury column of the manometer and becomes visible in the rhythmic fluctuation of the column of mercury which is synchronous with the pulse beat. Since the fluctuation will reach a maximum at the time when the pressure in the cuff is approximately equal to the diastolic pressure in the vessel, we are justified in considering the base of the manometer column at this time a measure of the diastolic pressure within the vessel.

Explanation of Diastolic Reading.

Oscillation of Mercury.

Since the development of the visual or oscillatory method of diastolic blood-pressure observations, newer and better methods have been designed. These

Other Criteria. are the tactile, the auscultatory and that by means of the Fedde indicator attachment. Each of which will be considered more fully later under the head of "application of the blood-pressure test."

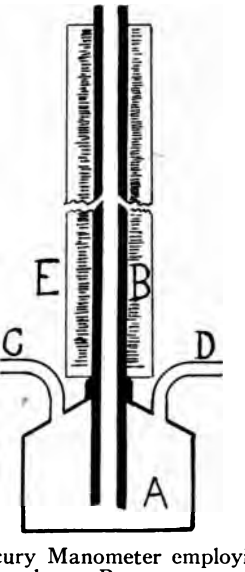


FIG. 4.—Type of Mercury Manometer employing a vertical tube. A, mercury-containing base; B, manometer tube; C, tube to armlet; D, tube to bellows; E, scale.

Good and Bad Apparatus. At the present time the market is flooded with instruments of all descriptions for estimating blood-pressure, so that it is important that the prospective purchaser should be able to separate the good from the bad, since the imperfect and poorly constructed instrument will be a constant source of inconvenience and may give very incorrect readings.

All these instruments may be roughly divided into two classes: First, those dependent upon the weight of a fluid column (usually mercury) which measures the pressure; and, second, those employing some form of spring or aneroid chamber.

Taking up the first class, we find that this can be divided into two divisions; one employs a vertical

The Mercury Types. glass tube emerging from the mercury chamber so that when pressure is exerted on the mercury, it is forced upward into the glass tube where the pressure is indicated in millimeters of mercury by an appropriate scale attached thereto (see Fig. 4).

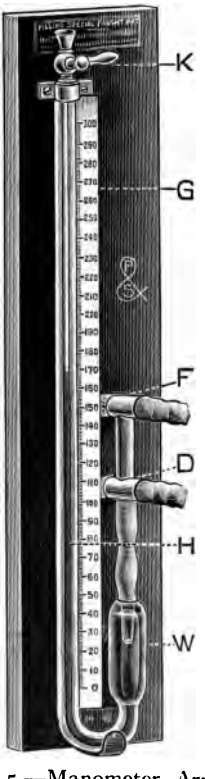


FIG. 5.—Manometer Arrangement of Pilling Special Sphygmomanometer.

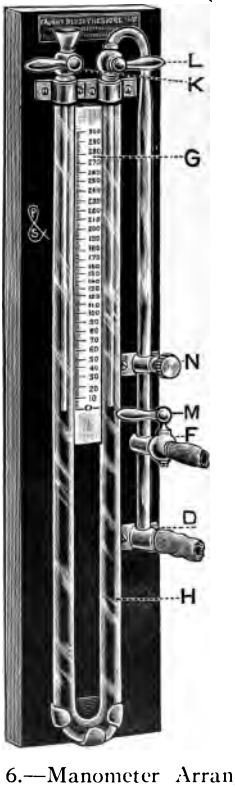


FIG. 6.—Manometer Arrangement of Faught Standard Sphygmomanometer.

The second group of mercury instruments employ a glass U-tube similar to that first used by Poiseuille (see Fig. 6), with the open ends up. This tube is partly filled with mercury and one limb is connected by means of suitable tubing with the rest of the apparatus. Pressure exerted within the system will cause the mercury to rise in one limb of the tube with a proportionate

fall upon the other. The difference in the level of the mercury in the two limbs will represent the pressure, which may be measured by a suitable scale placed between the tubes.

These two types depending upon a vertical column of mercury have little to choose between them and both are accurate and trustworthy at all times. The mercury at rest freely communicates with the atmosphere and is therefore not affected by barometric or thermometric changes.

Efforts to reduce the size and weight of the sphygmomanometer has resulted in the production of numerous types of mercury instrument having jointed tubes. These on account of their frailty are to be condemned, as they are usually out of service when most needed.

Aneroid or Pocket Type.

There are also several types of instrument employing some form of spring and aneroid chamber actuating a dial indicator for the recording of blood-pressure in millimeters of mercury. These are the so-called pocket instruments and have much to recommend them, provided they do not become inaccurate by use.

Faught Pocket Sphygmomanometer.

The Faught Pocket Sphygmomanometer consists of a gold-plated aneroid gauge with a white enamel dial bearing black and red markings graduated to 300 mm. Hg., a strong flexible sleeve and a metallic inflating pump, together with suitable rubber tubing for connections. When assembled these constitute a very simple and most reliable instrument, so compact that it is contained in a leather case, measuring 8 x 3½ x 1½ inches, and weighing complete about one-half pound; fitting easily in the pocket or bag.

Weight and Size.

This instrument has been devised to fill the long-felt need of a Pocket Sphygmomanometer which would combine portability and accuracy with durability and strength. The Faught Pocket Sphygmomanometer is an exact and efficient instrument and is employed by life

insurance examiners, hospitals and by most of the leading practitioners. It is compact, absolutely accurate, very sensitive, substantially constructed, and with ordinary care should last a lifetime.

FIG. 7.—Faught Pocket Sphygmomanometer in Case.

The "Fatigue of Metal."

A very important and distinctive feature possessed by the Faught Pocket Sphygmomanometer and found in no other instrument of similar character is the absolute elimination of the so-called "fatigue of metal" which heretofore has interfered with the accuracy of all other aneroid instruments. By persistent experiment and painstaking study a material for the construction of the compression disks has been found which is not affected in any way by temperature or pressure variations.

Perpetual Accuracy.

A Faught instrument was used for ward class demonstration for more than a year and when tested with the original standard mercury column was found as absolutely accurate as when originally tested. At another time, after one hour's constant use on about twenty students, a test for accuracy was immediately made, and the readings corresponded absolutely, both up to 300 and down again. THIS PROVES CONCLUSIVELY THAT THE FAUGHT POCKET SPHYGMOMANOMETER IS NOT AFFECTED BY CONSTANT USE AND THAT READINGS BOTH UP AND DOWN ARE IDENTICAL. No other aneroid can bear these tests.

These tests can be repeated by any one and the results will be the same. Try them and be convinced.

The Arm-band.

The arm-band is made of strong black inelastic, but soft and flexible material, having between its layers a rubber bag 9 x 5 inches. This measurement conforms to the requirements of Janeway and others, and has been found to give the most accurate readings under all conditions.

FIG. 8.—Arm-band.

The Faught Pocket Sphygmomanometer can be applied or removed in less than thirty seconds. The time required to apply the instrument, make a careful observation of the pressure and remove it is less than consumed by any other form of sphygmomanometer on the market.

For accuracy and sensitiveness, the Faught aneroid has all the advantages of the best mercurial instruments; for compactness and durability it far surpasses them. It is practically indestructible, and is well adapted to use in the operating room and in private practice, as well as in hospital service.

Reads up to 300 mm.

The dial, which is accurately graduated, reads in mm. Hg., as does the standard mercury column, each interval representing two mm., and ranges from zero to three hundred (Fig. 9.)

Dial Adjustable.

The dial also may be revolved without interfering with the internal mechanism, so that the pointer at rest can be adjusted to zero. Neither temperature nor atmospheric variation in any way affects the apparatus, since when both sides of the pressure

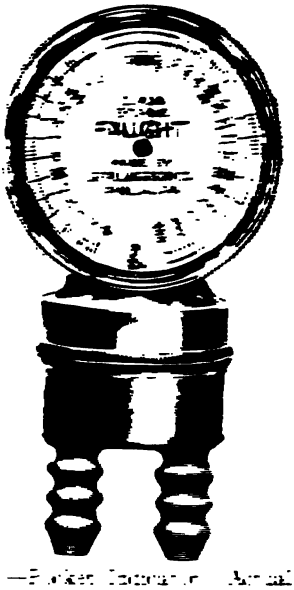


Fig. 9.—Pocket Indicator. Actual size.

The latest development in sphygmomanometers is the "Faught Clinical." This instrument follows a new principle which has been fully tried during several years in the Faught Pocket Indicator, and which has been fully demonstrated to be the most desirable and accurate multiple chamber aneroid instrument yet designed.

The Faught Clinical.

This instrument is shown in detail in Fig. 10.

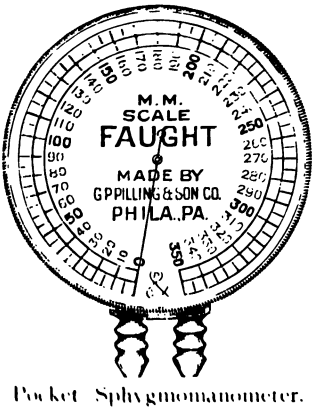


Fig. 10. Clinical Pocket Sphygmomanometer. One-half actual size. Diameter of dial, 3¼ inches.

The two characteristic features of this instrument are the large, easy-to-read dial, measuring 3½ inches working diameter, and a graduated scale with a range of 350 mm. Hg. The first and only sphygmomanometer to have a range sufficient to give accurate readings in every case, as it is now well established that pressures are not infrequently encountered that register well above 300 mm. (See article in *New York Med. Jour.*, June 11, 1910, by John C. Hirst.)

Large Dial reads up to 350 mm. Hg.

In general appearance the Clinical very much resembles the Pocket and, in spite of the larger scale, is contained complete with pump and arm-band in a case but very little larger than that of the Pocket Indicator.

The Faught Standard Mercury Sphygmomanometer is modeled after the U-tube type of apparatus and is designed to overcome the defects of the earlier instruments, to meet every requirement demanded of a modern sphygmomanometer and at the same time be easy to use, difficult to derange and as light and portable as is compatible with accuracy and strength.

Standard Mercury Sphygmomanometer.

The mahogany case, which encloses the complete apparatus, including the arm-band (see Fig. 11) and pump (see Fig. 16), measures 4 x 4½ x 16 inches and weighs 3 pounds 9 ounces. The lid is hinged at one end and when raised supports the working parts of the apparatus. A spring check allows the lid to be raised to a vertical position, where it is automatically held locked during the observation.

Size and Weight.

The "U" tube is provided with a scale which has been arranged to give the reading directly in millimeters of mercury.

A special and distinctive feature of the apparatus is the means of preventing loss of mercury from the manometer tube when the instrument is not in use. This is accomplished by means of two small cocks placed

Mercury well Guarded.

at either extremity of the "U" tube, and which are kept closed when the apparatus is not in use (see Fig. 6).

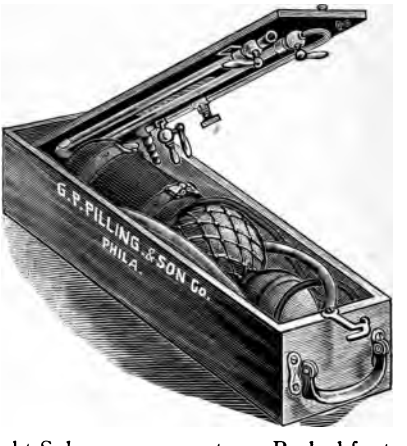


FIG. 11.—Faught Sphygmomanometer. Packed for transportation.

By eliminating all detachable parts, the time required to make the reading is reduced to a minimum. The only preliminaries to the test being to lift the lid, open three cocks and attach two tubes to their respective nipples.

To Operate the Faught Pocket and the Faught Clinical Sphygmomanometers.

Adjustment.

Apply the arm-band to the bared arm of the patient, above the elbow, by placing the broad end, containing the rubber bag, over the region of the brachial artery. Wrap the rest of the band as you would a bandage about the arm (see Fig. 12), and tuck the narrow end in under the first turn. Attach the indicator to the hook provided for that purpose; attach the pump to one nipple, and the tube from the arm-band to the other. See that the needle valve on the pump is fully closed. Hold the pump in one hand and locate the pulse at the wrist with the other. You are now ready to take the systolic pressure.

Pump sufficient air in the system to obliterate the

pulse, then by a fraction of a turn open the valve (see Fig. 12), gradually release the air pressure, and note the pressure indicated when the first pulse beat returns to the wrist. This is systolic pressure. Repeat the procedure one or more times to

Systolic Blood-pressure Test.

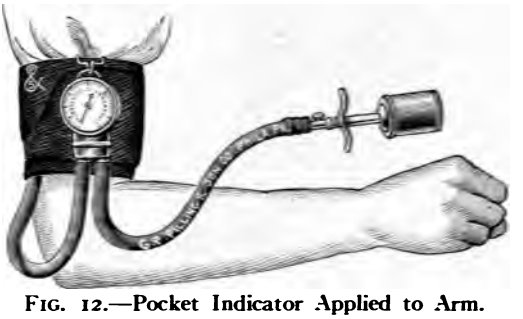


FIG. 12.—Pocket Indicator Applied to Arm.

insure correct readings. Work rapidly, as prolonged pressure upon the arm will affect the reading.

Again obliterate the pulse and allow the air pressure to gradually fall through the needle valve. As the pressure falls the needle will be seen to fluctuate in rhythm with the pulse; after a time this movement will become less and eventually disappear. The pressure indicated on the dial at that time will be the diastolic pressure.

Diastolic Blood-pressure Test.— Oscillation.

Obliterate the radial pulse, then gradually reduce the air pressure; when the pulse returns to the wrist it will at first be very feeble and thready, then it will come up full and strong under the finger. Take the reading at the moment the pulse become full and normal in character. This will be the diastolic pressure.

Palpation.

The auscultatory method of determining blood-pressure (Goodman and Howell, *Am. Jour. Med. Sci.*, Sept., 1911). The sphygmomanometer is applied in the usual manner, with the bell of the stethoscope over the artery at the bend of the arm. As the pressure is released a cycle of events follow in regular sequence.

Auscultation.

They consist of five phases which are clean cut and which have a definite relation to the differences between the extremes of pressure. With a normal systolic pressure at 130 mm. and a diastolic pressure at 85, the phases are:

First Phase. A loud, clear, snapping tone, which is the first phase. This serves as an index as to how far the pressure must fall before the column of blood can be sustained past the obstruction in the vessel caused by the cuff, at sufficient velocity and for sufficient duration to produce the murmur. Normally this phase covers 14 mm., and any increase or decrease in length should be noted. The advent of this sound indicates the systolic pressure.

Second Phase. Consists of a succession of murmurs, covers 20 mm. and is dependent upon cardiac effectiveness.

Third Phase. A tone resembling the first phase, but less marked and lasts 5 mm. This is dependent upon cardiac efficiency and also upon the character of the vessel wall. The more sclerotic the vessel and the greater the cardiac hypertrophy, the more favorable are the conditions for the production of a clear tone at this time.

Fourth Phase. This is 6 mm. A dull tone; a resilient vessel receiving a normal pulse shock, or a rigid vessel receiving a weakened shock. The pointer at this time indicates the diastolic pressure.

Fifth Phase. Disappearances of all the sounds.

Of these three methods the last is the more accurate and scientific. One point, however, must be borne in mind, readings in the text books and medical literature are based on the first and second methods. The third method will give readings of a slightly higher systolic pressure and a diastolic pressure of 10 to 15 mm. lower.

The Pulse Pressure. Having determined the systolic pressure and the diastolic pressure, the

diastolic pressure is subtracted from the systolic pressure and the remainder is the pulse pressure (see Fig. 1, page 9).

The Mean Pressure. To obtain the mean pressure, add one-half of the pulse pressure to the diastolic pressure (see Fig. 1).

FIG. 13.—Method of auscultatory blood-pressure test, using Faught pocket indicator and sphygmometroscope.

The Sphygmometroscope in Auscultatory Blood-pressure. In order to enable physicians to take the blood-pressure readings more accurately and to make them of greater clinical value to the profession as a diagnostic and therapeutic guide, Dr. J. F. Prendergast (*N. Y. Med. Jour.*, Jan. 11, 1913) has had devised and placed on the market the Sphygmometroscope (Ausculoscope). It consists of a two-inch band, to which is attached a metal bowl or cup, the face of which has a very delicate diaphragm, with a centre projection to fit more snugly to the surface of the arm over the brachial artery, just at or below the bend of the elbow. Flexible rubber tubes are connected with the drum or body of the instrument, to which are attached hard-rubber ear-pieces (see Fig. 14). It is called the Bowles sphygmometroscope, and resembles the Bowles stethoscope

with certain modifications; it is attached to the arm by a two-inch band.

The instrument is intended for use with any kind or form of sphygmomanometer, either pocket or mercury. Its method of application is to place the band on the arm one or two cm. (one-half to one inch) below the arm-band or cuff of the sphygmomanometer at the bend of the elbow,

Used with any Sphygmomanometer.

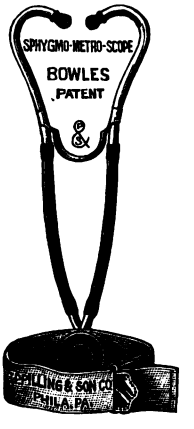


FIG. 14.—Sphygmometroscope.

having the projection on the diaphragm of the drum directly over the brachial artery before it divides into the ulnar and radial. Care should be taken to avoid pressure from this band upon the arm.

Pump the cuff, connected with the manometer, with air until the radial pulse is cut off, open the release valve, and allow the air to escape slowly from the arm-band. The first impulse or sound heard is a clear thump or tap caused by the sudden stretching of the walls of the relaxed vessel and the rapidity of the blood stream. This is the systolic pressure.

Where one is merely trying to read the systolic and diastolic pressures, it is not necessary to attempt to interpret the different phases. The essential thing to remember is that the first tap or sound is the

Systolic and Diastolic Pressure.

systolic pressure, and just at the disappearance of all sounds is the diastolic pressure.

Goodman and Howell say: "The auscultatory method is useful in differentiating certain organic and functional derangements. It was found that any arrhythmia which may be present is noted earlier by the ausculta-

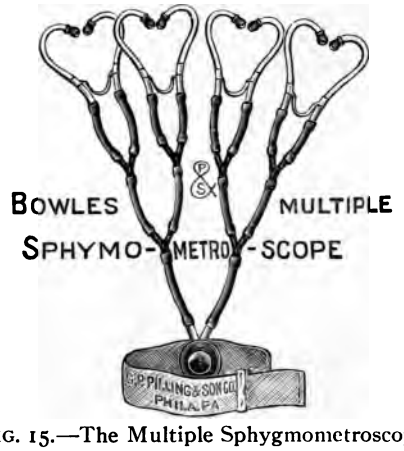


FIG. 15.—The Multiple Sphygmometroscope.

tory method than by feeling the pulse or listening to the heart. By this method true organic cardiac lesions can be differentiated from a neurosis. In organic lesions there is a uniformity in sequence of readings; in neuroses the readings are marked by variations in sequence and a variation in the systolic and diastolic pressures."

The Multiple Sphygmometroscope.

The accompanying illustration, Fig. 15, represents a new device to facilitate the teaching of blood-pressure readings by the auscultatory method. The chief drawback to the auscultatory method has been the seeming difficulty which the average physician has in learning to perceive and interpret the sounds heard over the artery. The idea suggested itself that if the sphygmometroscope were made into a multiple of four, whereby the sounds could be heard by more than one individual at the same time, it would overcome this difficulty and make it possible

Value of Instrument.

for anyone familiar with the sounds heard during auscultatory blood-pressure observations to direct the attention of a small group of observers during the actual performance of the test.

The G. P. Pilling Company, of Philadelphia, have taken up this suggestion, and this valuable instrument is now upon the market.

The device will be valuable particularly to the medical teacher, as it has been our experience that many students go through their clinical studies without ever actually hearing or seeing a demonstration. It is serviceable also in demonstrating to medical societies or groups of medical men conditions involving marked variations in pressure.

To Operate the Standard Sphygmomanometer.

The patient should be in a comfortable position and in a sitting or reclining posture. The instrument should be upon a level surface within easy reach of the examiner.

Preliminaries.

The lid is then raised until it locks in a vertical position. If the tube from the pump is not already connected to the nipple F, it should be firmly attached to it. The two mercury guard cocks K and L at the ends of the "U" tube should be opened and the escape valve N tightly closed.

The hollow rubber bag of the arm-band A should be firmly wrapped around the bared arm of the patient and securely bound there by the leather cuff and straps B (see frontispiece). The cuff should be applied snugly, but not with pressure, as it is not designed to compress the member, but only to restrain the inner rubber bag while pressure is applied to it.

Application of Arm-band.

The tube from the arm-band C is attached firmly to the nipple D. The cock in the nipple F is opened.

This arrangement forms a continuous closed pneumatic system communicating freely with the manometer tube of the instrument. Now when pressure is raised

in the arm-band by the hand-pump, the amount of force exerted is indicated by the rise of the right-hand column in the manometer tube H, the height of which will be indicated on the scale G in millimeters of mercury.

To obtain the Systolic Reading.

With one hand find the pulse at the wrist of the arm, to which the arm-band has been applied. The fingers should be in a comfortable position and under no circumstance should be moved during the observation. Care should also be observed that the pulse is not cut off by undue pressure of the palpating fingers. The cuff should be in the same horizontal plane as the subject's heart.

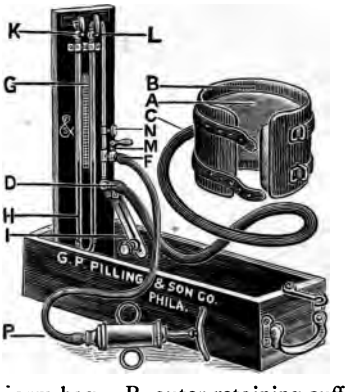


FIG. 16.—A, inner arm-bag. B, outer retaining cuff. C, tube from arm-band. D, nipple for tube from arm-band. P, pump. F, nipple for pump tube. G, millimeter scale. H, manometer tube. I, link-brace and lock. K, mercury guard cock. L, mercury guard cock. M, pressure guard cock. N, release valve.

While the pulse is thus under observation, the pressure in the apparatus is raised by means of the hand bellows or pump until the pressure within the constricting band is sufficient to prevent the impulse from reaching the wrist. When this is accomplished the cock in the nipple M is closed to eliminate the elastic pressure. Now by a fraction of a turn in the valve N the pressure in the system is slowly released. During this part of the procedure, a close watch should be kept upon the height of the mercury column and for the return of the first pulse beat at the wrist. The level of the mercury

column at the instant that the pulse passes the compression-band will represent the systolic pressure in the vessel under observation. It is advisable to repeat this procedure a few times to check the correctness of the finding.

The diastolic pressure may be obtained in several

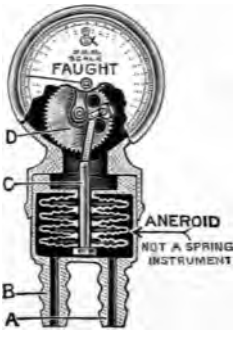


FIG. 17.—Diagram of internal mechanism, showing compression chambers.

ways. The method employed will depend upon the character of the instrument used and the method of preference of the operator. The readings obtained by this instrument correspond closely to those obtained by auscultation. The methods will be described in the order in which they have been devised.

To Obtain the Diastolic Pressure.

1. Visible Method.

This depends on the to-and-fro motion imparted to the mercury in the "U" tube, which occurs after the pressure has fallen below the systolic point. Having determined the systolic pressure, again raise the pressure to a few millimeters above this point and immediately close the valve M. Now allow the pressure to fall very slowly by releasing the air through the valve N.

As the mercury falls below the systolic point it will be noted that it acquires a rhythmic motion corresponding in time to the pulse. This will be found to gradually increase in amplitude up to a certain point,

after which it decreases and finally ceases before zero pressure is reached. During this gradual fall, the base of the mercury column, when the mercury is mak-

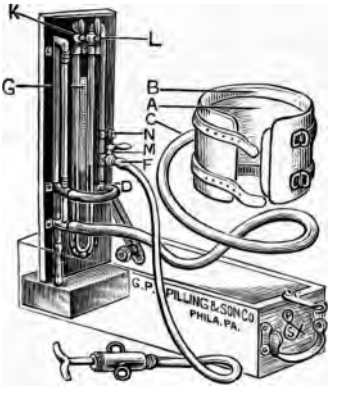


FIG. 18.—Fedde Indicator as Component of Standard Sphygmomanometer.

ing the greatest excursion, represents the diastolic pressure.

2. Palpatory and 3. Auscultatory Methods. These are the same as are described under Pocket Apparatus on page 23. (See Fig. 13.)

4. Diastolic Indicator. This is very similar to Method No. 1, except that the movement of the mercury column is ignored and the movement of the pith ball in the small vertical tube relied upon to determine the diastolic pressure.

By reference to Fig. 18 it will be noted that the narrow perpendicular glass tube contains a small, light ball of pith or cork which is free to move up and down within the tube.

When determining the systolic pressure pay no attention to this indicator, as each impact of air will make the ball dance violently, but this has no bearing on the test. When the pressure has reached the systolic point, close the valve N, when the ball will begin to move slightly in rhythm with the pulse. This motion gradually increases, until it reaches a maximum as the level of the

mercury column gradually falls, when, quite suddenly, its motion becomes markedly less. At the moment of this reduced movement the level of the mercury will indicate the diastolic pressure.

It must be borne in mind that the latter two methods give a diastolic pressure considerably lower than 1 and 2 (about 10 to 15 mm.).

To obtain accurate and reliable clinical data with the sphygmomanometer, it is important that some systematic technic be adhered to, and that all observations not only on the same patient, but in all cases, be made under as nearly the same conditions as possible. Attention to detail will eliminate largely the errors arising from such factors as position of the patient, presence of fatigue or mental excitement, arm used for observation, etc. It is also valuable to note the apparatus used, the time of day, the pulse rate, the sex and age of the patient.

Cautions.

Care should also be taken to see that the observation is not too prolonged, for the interruption of the circulation in the extremity will, if continued, itself cause changes in pressure.

No single reading should be accepted when it is possible to make more than one. It is better to see the patient a number of times under varying conditions before deciding what his blood-pressure is.

The following printed record form has been taken from the Author's work on Essentials of Laboratory Diagnosis, 4th edition, F. A. Davis Co., Philadelphia, 1912. This will be found useful for keeping a complete record of the Blood-pressure Test, also the chart as shown in Fig. 19 (page 32) is valuable where a series of observations are made upon one patient. This chart is arranged to keep the readings in graphic form, similar to the usual temperature chart.

Form of Recording.

Blood-pressure Determinations.

CLINICAL REPORT.

.....

....

Apparatus {

Width of Cuff cm.
Part examined,
Right,
Left,
Posture,
Pulse Rate,

Systolic	mm. Hg.	after 10	Bending	Movements,	mm.	Hg.
Diastolic	mm. Hg.	" "	"	"	"	
Pulse Pressure	mm. Hg.	" "	"	"	"	
Mean Pressure	mm. Hg.	" "	"	"	"	

Remarks.

Time of Day. A.M.....P.M.....

Date.....

Examined by.....

Some observers prefer the graphic charts which show the variation in blood-pressure and pulse in the same manner as the temperature chart.

Graphic Chart.

The accompanying cut shows a chart which has been carefully prepared and which is arranged to show both systolic and diastolic pressure, together with pulse rate, in such a manner that they do not become superposed. These may be obtained on the market in pads of 25 for a nominal figure or directly by writing to G. P. Pilling & Son Co., Philadelphia.

Faught Chart for Blood-pressure Records.

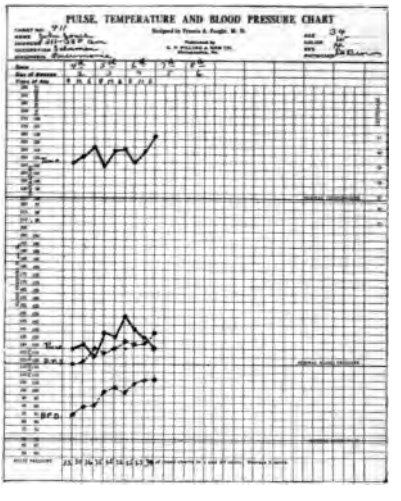


FIG. 19.—New blood-pressure recording chart about one-quarter working size. Designed to record systolic pressure, diastolic pressure, pulse rate and temperature.
Published by G. P. PILLING & SON CO., Phila., Pa.

NORMAL BLOOD-PRESSURE AND THE CAUSES OF VARIATION.

Meaning of Normal Pressure.

When normal blood-pressure is spoken of in discussion, it is accepted to mean that the pressure in each individual case is within the recognized normal limits determined by clinical experience. This is not and cannot be a fixed pressure, as the normal temperature is a fixed degree. This is because blood-pressure at any given moment is the result of a combination of variable factors, which must unite to determine it, and because it has been found by experience that blood-pressure is regularly influenced and modified by the age and sex of the individual.

There are several methods of arriving at an estimation of the normal pressure and its variations in a given

case. Thus we can adhere to a table based on a large clinical and experimental study. Such a table, which conforms to the accepted standard, has been compiled by Woley. The normal average systolic pressure can be readily determined for all ages by employing a formula, devised by the author several years ago. This is based on the experimental study of many observers, and is designed to estimate the age factor thus: "Consider the normal systolic blood-pressure of a healthy adult male, age 20, to be 120 mm. Hg. Then for any two years of life over this add 1 mm. Hg. to 120. Thus at age 30 blood-pressure equals 125, at age 60 it equals 140, etc."

Method of Estimating Normal Average.

The sex factor can be roughly reckoned as minus 10, so that all pressures as computed by this formula should have 10 mm. subtracted when estimating the average normal pressure for women.

It is accepted that other factors which are usually part of the daily life of an individual will somewhat influence the blood-pressure; thus:

PHYSICALLY WEAK persons will usually show a slightly lower pressure, often 5 to 10 mm., while the MUSCULARLY DEVELOPED will have a slightly higher average, about 5 to 10 mm.

The pressure after EXERCISE will be found from 10 to 20 mm. above the average, but will rapidly return to normal. The same may be said of the first hour after a hearty meal.

INGESTION OF LARGE AMOUNTS OF FLUID, particularly if ALCOHOLIC, will cause a moderate and brief rise.

Pain and anxiety are often a cause for a sharp and short rise.

POSTURE will affect the reading, and its effect is largely if not entirely due to the effect of gravity and the relation of the arm-band to the chief volume of blood in the body.

It has been found that blood-pressure rises in the brachials, as posture changes from the standing to the head low (Trendelenburg) posture, and that the change

is least in alterations from the standing to the sitting posture. The pulse rate is reduced a few beats and the pulse pressure in normal individuals is increased.

TIME OF DAY has a modifying influence on blood-pressure, being usually lowest during the early hours of profound sleep, rising slightly toward morning, and rising more or less rapidly, depending on the mental and physical activities of the individual, as the day advances. This variation may reach as much as 40 mm. Hg.

AGE.—There are, as far as has been ascertained, no tables giving the various pressures found in children of different ages.

During the first years of life the systolic blood-pressure varies from 75 to 90 mm. of mercury.

According to the observations of Lauder Brunton, the maximum pressure in children from 8 to 14 years is 90 mm. of mercury. In youth between 15 and 21 years, 100 to 115 or 120 mm. Hg.

ALTITUDE.—Considerable reduction in barometric pressure, such as occurs in change from low to high altitude, causes in the healthy individual a slight reduction in blood-pressure level, affecting both the systolic and the diastolic pressures. This effect becomes less marked as the subject becomes accustomed to the change. The change usually amounts to from 3 to 10 mm., occasionally as much as a 20 mm. rise has been noticed.

In tuberculous subjects with hypotension, high altitude (6,000 feet) causes a rise in pressure (Peters, *Arch. of Int. Med.*, Aug., 1908).

EATING.—The blood-pressure normally rises from 10 to 15 mm. shortly after an ordinary meal, gradually falling toward the original level after an hour or more. The size of the meal is thought by some observers to affect the degree of elevation, being greatest after heavy meals which contain much proteid.

It is well recognized that certain changes in the circulatory system originate from disturbances in the digestive tract. These are usually seen in a slight increase in blood-pressure, due to the reflex from the

splanchnic area affecting the muscular walls of the arteries. This may be considered normal to a certain degree, but it becomes pathologic where we find this elevation to be excessive and prolonged.

Alimentary hypertension is the result, therefore, of a normal abdomino-arterial reflex, made excessive by an over-abundance of food or an incomplete elimination of toxic substances. This continued hypertension is often the first link in the chain leading to arteriosclerosis, contracted kidneys and apoplexy.

Alimentary Hypertension.

DRINKING.—Excessive ingestion of water causes a brief rise of blood-pressure amounting to about 5 to 10 mm., although the habitual use of ordinary amounts need hardly be considered in any blood-pressure estimation. Large amounts of beer may be the cause of a sharp rise, which, when repeatedly recurring, as in habitual beer drinkers, may become the cause of a permanent hypertension which may finally result in arteriosclerosis and chronic nephritis. Strong alcoholic drinks cause a primary rise from heart stimulation followed by a secondary fall when vasodilatation occurs.

SMOKING.—Smoking usually causes an elevation in blood-pressure with the apparent paradox that many habitual smokers have a subnormal blood-pressure. The usual effect of one or two cigars, or its equivalent in other forms, in those accustomed to the use of the drug, is a sedative action, and a slight lowering of blood-pressure, while excessive smoking, during a short period of time, causes a rise of from 5 to 25 mm.

PERMISSIBLE VARIATIONS.—From the foregoing it would seem that any study of blood-pressure must have its value greatly reduced by so many modifying factors, but careful thought will show that these at most cause only slight variation, which need not obscure the issue. Experience will teach the observer to unconsciously include these factors in practice, and enable him to arrive at the correct value of his findings by aid of them.

PATHOLOGIC BLOOD-PRESSURE.

Abnormal blood-pressure may be either above or below the normal level, as compared to the normal average pressure and its variations.

Abnormal Blood-pressure.

Blood-pressure should only be determined as abnormal after careful study and repeated tests, unless the change is so marked as to be beyond question.

A single reading slightly above or below the normal boundaries may be occasioned by some accidental or peculiar incident, and should therefore not be taken too seriously and should never be assigned to an important rôle in diagnosis until its persistence has been demonstrated on at least two occasions.

Neither should one expect to find the same pressure, in any case, at all times. Never lose sight of the possible causes of normal variation. These normal variations may occur in a very short space of time, and should not, as in at least one instance known to the author, condemn the instrument, showing such variation, as inaccurate. Remember also that your unfamiliarity with a new type of instrument may cause you to neglect some detail, which will invalidate your results.

Study your instrument, read your instructions, and be sure of our technic.

For a proper understanding of the treatment of the various conditions associated with which the arterial pressure is above normal, it must primarily be recognized that if the pressure is high there must be some underlying cause for the abnormality. Such cases can, as a rule, be divided into three groups: mechanical, nervous and toxic. The most common mechanical cause is arteriosclerosis, and yet there may be pipe-stem arteries with normal pressure. The reflex nerve irritation of a peritonitis or a fright may cause a sharp rise in pulse tension, but in shock the blood-pressure falls. The cause of hypertension, which is probably the most widespread and the most frequent, is intoxication. It is generally considered that it is

Arterial Hypertension.

the irritation from poisons retained by the kidneys, and not the mechanical obstruction, which sends the blood-pressure up in nephritis.

Continuous high pressure is seen in certain forms of NEPHRITIS. Thus, in primary acute Bright's disease and in nephritis secondary to scarlet fever, there is practically always a marked rise in arterial pressure. A rise amounting to more than 50 mm. Hg. has been observed within 48 hours of the onset of an acute nephritis. Elevated pressure is also found in beginning ARTERIOSCLEROSIS of the first part of the aorta and of the splanchnic vessels.

In dealing with the elevation of pressure, which is the result of the action of drugs or of toxic agents, it is important to bear in mind that the amount of the substance and its concentration, its potency as well as the duration of its action will determine the amount of elevation, the duration and the permanence of the effect.

Arterial Hypotension.

This term is applied to cases presenting a more or less continuous blood-pressure below the normal estimated pressure. A pathologic depression in blood-pressure may be caused by the depressing influence of CIRCULATING TOXINS acting either upon the heart blood-vessels or controlling nervous mechanism or to sudden withdrawal of a large volume of blood from the circulation, as in HEMORRAGE, after venesection, copious diaphoresis, diarrhea, or in shock.

THE LOWEST BLOOD pressure compatible with life has been reported by Neu to be from 40 to 45 millimeters of mercury, and this only occurred with subnormal temperature in the moribund state. He has seen recovery after a fall in pressure as low as 50 millimeters.

Lowest Safe Pressure.

In general it may be said that lowered blood-pressure is of little significance except after hemorrhage or during surgical shock. Here the great and sudden reduction in pressure may be sufficient to immediately endanger life.

It is noted that a moderate and progressive fall in pressure occurs in most progressive and prolonged fevers,

as in typhoid fever. When due to such a cause the depression is rapidly overcome and disappears as convalescence is established.

Widespread dilatation of the vessels and consequent lowering of blood-pressure has been noted in the last stages of ARTERIOSCLEROSIS.

Arterial dilatation and lowering of blood-pressure may result from general loss of arterial tone. Thus if the splanchnic vessels become widely dilated and filled with blood, the other arteries are insufficiently filled (there is insufficient blood in the body to properly fill the arteries if they are all widely dilated) (see page 54), and the pulse becomes soft, the temperature falls and syncope finally ensues.

Shock.

Criles' exhaustive experiments would seem to show that SURGICAL SHOCK is caused by exhaustion of the vasomotor centres, which renders them unable to maintain the normal tone of the vessels, so that the pressure falls often to a point sufficient to endanger life.

CHAPTER IV.

CONDITIONS IN WHICH THE BLOOD-PRESSURE READING IS OF DEFINITE CLINICAL VALUE.

As already stated, the relation of blood-pressure in disease, compared to the estimated normal in health, may be variable (slightly above or below), may tend to hypotension, and may show high pressure. The arrangement of the various conditions treated in the following pages is entirely arbitrary, being based on a plan which renders the material most readily accessible and easily obtainable for immediate reference.

HIGH BLOOD-PRESSURE IS A SYMPTOM NOT A DISEASE. It is present in a number of common pathologic conditions, and when found aids greatly in explaining certain phenomena connected with the heart, blood-vessels and kidneys. The state of the blood-pressure often furnishes the one important clue which leads to correct diagnosis or directs the attention to an altogether unsuspected complication.

Importance of High Blood-Pressure.

For example, a case of pneumonia is related in which all was progressing satisfactorily until one day the patient did not seem to be as well as the state of his disease would warrant. A blood-pressure test made by a consultant who had been called demonstrated an abnormally high blood-pressure. The urine was then examined and evidence sufficient to establish the presence of a complicating nephritis was found.

At the present time certain diseased conditions are well recognized as being productive of or usually accompanied by an elevation in blood-pressure. The two almost classical high blood-pressure conditions are arteriosclerosis and acute and chronic nephritis. Other conditions in which a high pressure is often found are chronic myocarditis, the complications of arteriosclerosis, as angina pectoris and apoplexy. Also uremia, the toxemia of pregnancy, lead poisoning, peritonitis and cerebrospinal meningitis.

Conditions with High Pressure.

CONDITIONS IN WHICH HIGH BLOOD-PRESSURE IS A PROMINENT SYMPTOM.

Arteriosclerosis.

This is a disease with high blood-pressure. The systolic blood-pressure will be found to be between 180 and 280 mm., although cases may be met in which the superficial vessels are markedly sclerosed and yet the blood-pressure may be normal or even below. These are probably cases of localized sclerosis which does not involve the larger vessels, particularly those of the splanchnic area. Other cases of very high pressure may occasionally be encountered in which it is impossible to find the cause, either in the heart, blood-vessels or kidneys. These cases have not yet been satisfactorily explained.

As a rule, the degree of elevation in pressure will indicate the extent of arteriosclerotic involvement. The pressure of a complicating nephritis, myocarditis or an aortic regurgitation will tend to further elevate the blood-pressure. The terminal stage of a long-standing arteriosclerosis, even when complicated by other conditions causing high blood-pressure, is usually marked by a falling and finally a subnormal blood-pressure.

The blood-pressure test in cases of arteriosclerosis is often of great assistance in following the effect of treatment and in forecasting the approach of the terminal stage.

Angina Pectoris.

This is usually a syndrome, developing in the course of a case of general arteriosclerosis, and denotes involvement of the coronary arteries in the arteriosclerotic process. The blood-pressure rises just before and remains high during the paroxysm of pain, subsiding shortly thereafter. The rise may amount to 50 mm. and there may be little or no elevation in blood-pressure during the interval. The reduction of high blood-pressure in those with a tendency to angina is often most successful in preventing subsequent attacks.

A sharp rise in blood-pressure is usually the first sign of the onset of an acute nephritis. This complication, developing in the course of an acute infection, may be discovered by a routine study of the blood-pressure, where the rise may antedate the development of the usual signs, including alterations in the urine by as much as twenty-four hours. This fact should be a most emphatic indication of the value and importance of daily blood-pressure readings during the course of all infections, particularly scarlet fever.

Acute Nephritis.

A gradually developing chronic nephritis is shown by a gradually rising blood-pressure accompanied by the usual alterations found in the urine. A high blood-pressure reading for more than 200 mm. found during the examination of any patient should place one on guard and start a careful examination for other signs of this condition.

Chronic Nephritis.

The blood-pressure in chronic nephritis is persistently elevated and may be extremely high. Pressures of over 300 mm. have been reported. A sudden further rise in pressure occurring during the course of a chronic nephritis is often a most valuable warning, as a sign indicative of an impending uremic attack. This rise, if noted early, furnishes the basis for immediate action, to control the pressure by powerful eliminative measures in order to avert if possible the uremic attack. Such treatment is often very successful.

A study of blood-pressure in cases showing transient or persistent traces of albumen in the urine will often serve to demonstrate the cause and seriousness of this condition, because it is well known that high blood-pressure is always an accompaniment of chronic nephritis, and also because it is believed that a normal blood-pressure, even with albumen in the urine, places the albumen in a class with minor and not serious affections. Unexplained persistent high blood-pressure, even when albumen cannot be demonstrated in the urine, furnishes ample grounds for strongly suspecting chronic changes in the kidneys.

Chronic Parenchymatous Nephritis.

The few available reports on blood-pressure in this disease fail to show that a high blood-pressure is an accompaniment of it or that the blood-pressure bears any relation to the duration or severity of the kidney inflammation.

Uremia.

This often fatal complication of nephritis is accompanied by a sudden and often sharp rise in an already greatly elevated blood-pressure, or else an already high pressure begins to mount upward to a dangerously high level. These changes in blood-pressure may, by careful observation with the sphygmomanometer, be noted sufficiently early to allow time for the institution of preventive measures, directed toward the relief of toxemia, by increasing elimination. The blood-pressure during an uremic attack may be far above 300 mm. Actually how high has not been recorded, because before the development of the Faught Clinical Sphygmomanometer, no instrument was capable of recording pressures above 300 mm.

In patients who are seen in emergency and are found profoundly unconscious, the sphygmomanometer will often be the means of separating the coma of uremia with high blood-pressure from coma of other origin.

In Valvular Lesions.

In the study of the valvular disease of the heart the results do not seem to have special bearing upon the primary condition (defective valve) except in cases of aortic regurgitation. This is in part due to the usual complicated nature of the condition, which often includes arterial and myocardial changes and involvement of the kidneys.

The chief value of the sphygmomanometer in the study of heart conditions applies to the condition of the myocardium, to a demonstration of the effect of therapeutic measures, and as a guide in prognosis and in the general management of cases. With it we are able to determine with considerable accuracy the benefit derived from the drugs and other measures employed. In this we may guard against insufficient or improper treatment and

also against the over-use of these same measures by demonstrating the therapeutically efficient dose and the proper interval of its exhibition.

The blood-pressure test may be sufficient to establish a diagnosis in pure aortic regurgitation, the great pulse pressure occurring in this condition being almost pathognomonic. Referring to the physics of the circulation, we find that in aortic regurgitation the left venticle is called upon to deliver an abnormally large volume of blood into the aorta to supply the demands of the circulation. This is because the heart is required not only to furnish sufficient blood for the needs of the body, but must also inject into the aorta at each systole enough surplus to compensate for the regurgitation of a large volume of blood into the left ventricle during diastole. The natural result of the sudden injection of this large amount of blood into the arterial system will be to cause a sudden and great rise in systolic blood-pressure (immediately succeeding systole, the blood disperses in two directions, forward through the capillaries and backward into the ventricle, producing the phenomenon of the water-hammer pulse). Thus the pressure rapidly falls and the diastolic pressure is abnormally low. THE COMBINED RESULT OF THIS HIGH SYSTOLIC AND LOW DIASTOLIC PRESSURE IS A GREAT PULSE PRESSURE. This may amount to 100 mm. or more.

Aortic Regurgitation.

In the presence of moderate or high-grade generalized arteriosclerosis, this phenomenon is further accentuated because the lack of normal elasticity in the arterial system tends to reduce the diastolic pressure to zero.

Occasionally, in cases of mitral stenosis, the blood-pressure may tend toward a low level, but this is usually more than compensated for by the accompanying changes in the heart muscle and larger arteries.

Many cases of chronic myocarditis have sufficiently marked signs to be easy of diagnosis; in other cases of the cardiovascular renal type diagnosis may be extremely difficult. Here it is most important that the general

Myocardial Degeneration.

practitioner should be able to recognize these changes sufficiently early to be able to institute treatment with good chance of arresting the progress of the disease indefinitely or as long as the patient adheres to his new regime. These cases usually occur in middle life, and may be far advanced before discovered, as they often are, accidentally, in the course of examinations for life insurance. The difficulty of correctly estimating them is great, for, while we may be morally certain of the existence of heart weakness, we may not be able to prove the existence of myocarditis, and often erroneously class them as nervous or functional.

Occurrence.

The history and examination of these cases is of great importance, especially in regard to the past incidence of acute infections, including syphilis; the etiologic factors of alcohol, overindulgence at table, excesses in tobacco, profound mental strain, worry, lack of outdoor exercise and chronic intestinal intoxications must also be considered. The development of cardiac symptoms in such persons in the absence of definite lesions may be looked upon as presumptive evidence of some degree of chronic myocarditis. This view is strengthened if the case is accompanied by elevation of blood-pressure, which, while it may not be great, will be found to be constant, and by the appearances of irregular slight arrhythmia, slight dyspnea and some edema of the ankles. It must be remembered, however, that there may be no elevation in blood-pressure if the myocardial weakness is extreme, and that a generalized arteriosclerosis or a contracted kidney or both will give a greater elevation of blood-pressure than the myocardial condition alone would warrant.

Etiology.

In the physical examination the state of the superficial vessels, together with the pulse rate and particularly the reaction of the heart to posture and exercise as determined by the sphygmomanometer, is all-important. This latter may be determined by the following tests:

Moderate exertion raises pressure in normal hearts

and this rise is sustained during it if not unduly severe or prolonged. In weakened heart muscles from any cause a primary rise may occur, but is quickly followed by a fall; in the worst, a fall occurs from the first.

Functional Tests.

This is based upon the alteration in pulse rate occurring in normal individuals on change of posture from the standing to the recumbent. Normally, the number of pulse beats per minute is from seven to ten less in the recumbent position; but when chronic myocarditis develops this difference tends to disappear, so that in seriously weakened hearts the pulse may be as rapid in the recumbent as in the sitting posture.

Shapiro's Test.

This is based upon the physiologic fact that a given amount of exercise, such as ten bending movements or running up a flight of stairs, causes an acceleration in the pulse rate and an elevation in blood-pressure. But the latter does not appear coincidently with the former; or if, as in some cases, the pressure does rise first, it fails to rise again after the pulse has returned to normal. It is this secondary rise which indicates a good heart muscle. A not too seriously affected heart may show a rise in blood-pressure immediately after the exertion, but with the slowing of the pulse the pressure will be found to have fallen to a level lower than before the experiment. The sphygmomanometer is required for an accurate demonstration of these changes in pressure, which may be recorded in definite units of meaure for future reference and comparison.

Graupner's Test.

IT IS NOT ADVISABLE TO APPLY THIS TEST TO PATIENTS WITH EXCESSIVELY HIGH BLOOD-PRESSURE, IN THOSE OF APOPLECTIC TENDENCY OR IN THOSE WITH HIGH-GRADE ARTERIOSCLEROSIS. The test is unsafe in those with a systolic pressure of 200 millimeters or over. In such cases there is danger of ocular or cerebral hemorrhage or acute dilatation of heart.

Cautions.

The test will be difficult if not impossible of application in women unless all tight clothing is removed.

Valvular disease is not necessarily a contraindication to this test, as the condition of the myocardium seems to be the only important factor, except in aortic regurgitation with high pressure, so that the presence of valvular lesions need not detract from the value of the information obtained by this test.

Eclampsia. Blood-pressure is usually high, but may occasionally, in very severe cases, be low. Pressures have been recorded as being over 320 mm. See also page 57.

Cerebral Hemorrhage. The occurrence of a cerebral hemorrhage is usually preceded by a long period of high blood-pressure, accompanying a nephritis, an arteriosclerosis, or both. It is not the degree of permanent elevation so much as a sudden rise in an already high blood-pressure that causes the vessel to rupture.

Thus cases of arteriosclerosis, showing an average systolic blood-pressure of 225 mm., have, following a rise of 30 or 40 mm. more, suffered an apoplexy. On the other hand, the author has seen more than one case of chronic nephritis, registering pressures frequently above 250 mm., occasionally over 300—one case almost 310, without the occurrence of anything more serious than a mild cerebral edema of very transitory character. The sphygmomanometer will be found of great value in studying all high-pressure cases, in order to discover sudden rises and to permit their arrest in time to prevent catastrophe.

Migrain. Migrain is usually accompanied by hypertension, which may, according to Russell, be localized and confined to the arteries upon one side of the body, particularly those of the head. The discovery of hypertension in any case, the subject of periodic attacks of hemicrania, will furnish reasonable ground for therapeutic endeavors, as it has been shown that the reduction of hypertension by eliminative measures, in

these cases, is often successful in preventing, or at least reducing, the severity of the attacks.

Plumbism or Chronic Lead Poisoning.

Chronic lead-poisoning, accompanied by attacks of colic, are usually attended with an increase in blood-pressure. Temporary elevations of 30 or 40 mm. have been recorded. The fact may be of value in differentiating colic due to lead from renal and biliary colic in which the blood-pressure is low.

Ocular Manifestations of High Blood-pressure.

It has long been recognized that high blood-pressure is an important factor in several eye conditions, but not until recently has this knowledge been put to practical clinical use by the ophthalmic surgeon.

Tortuosity of Vessels.

Arteriosclerotic changes in the retinal vessels will immediately suggest the necessity of a blood-pressure test. The finding with the sphygmomanometer will reveal the significance of the eye condition by demonstrating the degree of general arteriosclerosis present. This knowledge may be put to practical use by instituting measures directed toward relieving the high pressure and by modifying the individual's life and habits in an effort to arrest the arteriosclerotic process.

Ocular Hemorrhage.

Fox and Batroff report in detail a study of one hundred consecutive cases of ocular hemorrhage in which the blood-pressure test was employed. In 80 per cent. of these cases hypertension was encountered. Forty per cent. of the cases of retinal hemorrhage were accompanied by chronic interstitial nephritis. Arteriosclerosis was present also in 27 per. cent. and parenchymatous nephritis in 13 per cent.

Glaucoma.

High blood-pressure is a common accompaniment of acute glaucoma, and is believed to be in the relation of cause and effect in the majority of cases. Relief from the high general

Surgical Relation. arterial pressure may greatly aid in arresting the disease, but it is the relation of this disease to surgical procedures directed toward its relief that the sphygmomanometer is of greatest value to the ophthalmic surgeon.

Cataract Operation. No careful surgeon ever attempts to enter an eye either in cases of glaucoma or cataract without first carefully studying the blood-pressure. The indications in the presence of a high blood-pressure are first to reduce the pressure and then operate. This method will save a large percentage of eyes which were formerly lost by intraocular hemorrhage; a complication the direct result of a sudden reduction of tension in an eye, having diseased blood-vessels, which were unable to withstand the sudden loss of support following the scleral incision.

DISEASES IN WHICH THE BLOOD-PRESSURE IS NOT GREATLY AFFECTED, BUT IN WHICH INFORMATION OBTAINED BY THE SPHYGMOMANOMETER IS OF VALUE.

In asthma the value of the blood-pressure reading will depend upon the variety of this disease encountered.

Asthma. In cardiac asthma the pressure is, as a rule, low. The finding of low blood-pressure accompanying a case of cardiac asthma is an indication for support of the heart and circulation; improved heart-tone and a better circulatory equilibrium being followed by a lessening in frequency and lengthening of the interval between attacks.

IN ASTHMATIC ATTACKS of other origin the blood-pressure is variable, and unless markedly altered from the normal is of little significance.

The general condition of the patient will influence the blood-pressure finding. The occurrence of hypotension in chronic bronchitis will suggest the advisability of tonic measures directed toward improving cardiac and blood-vessel tone.

Chronic Bronchitis.

The character of the tumor and the rapidity of its growth seem to exercise a certain definite influence on blood-pressure. Brain tumors of syphilitic origin are usually accompanied by an elevated blood-pressure. This is probably the result more of the effect of the circulation of the specific toxin of the disease on the arterial walls, causing a tonic spasm of the muscular coats, than from the effect of the pressure of the gummatous tissue in the brain. Cerebral tumors (neoplasms) are usually of slow growth (as compared with an apoplexy) and rarely have any great influence on blood-pressure. The more rapid the tumor formation the more likely is an elevated blood-pressure to be present.

Cerebral Tumor.

Tumors of special location, which may influence cardiac or vasomotor centres, are prone to show their influence on the blood-pressure, the elevation or lowering of which will depend upon the regions involved.

This condition is usually accompanied by a reduction in pressure, although this may not be sufficient in degree to be noticeable. This lowering of blood-pressure is in all probability due to the influence of pain upon the vasomotor system.

Neuralgia.

Neurasthenia is believed to be accompanied by a hypotension. This appears to be apart of the general loss of tone present in this disease and may be a rough indication of the severity of the exhaustion state.

Neurasthenia.

It is well known that, in active men who are approaching middle life, the insidious development of arteriosclerosis or chronic nephritis or both, frequently shows itself in a symptom-complex comprising irritability, lack of concentration, a feeling of lost confidence in one's self, sleeplessness, general fatigue, etc., a combination of symptoms often occurring in true neurasthenia. In these cases a study of blood-pressure is most important as a guide to diagnosis, a heightened blood-pressure often being the one sign by which the true diagnosis is reached.

Some observers, notably Sallom, have advanced the theory that the size of the arm has a direct modifying influence on blood-pressure readings, to such an extent that large arms cause a high reading and that a low pressure is obtained on small, thin arms. This is an error, based on a false premise, and both physiologic and clinical evidence fully bear this out. The size-of-arm factor has no bearing on the blood-pressure reading. Obesity, therefore, *per se* has no modifying influence on blood-pressure. The relative level of blood-pressure found in any case of obesity will not depend on the size of the arm, to which the cuff is applied, and will be normal for the age of the individual examined, unless the excessive fatness is in relation of cause or effect with some anatomic or pathologic change, in the heart, blood-vessels or kidneys.

Obesity.

Insanity (mania), the mental state of the case at the time of examination will largely determine the pressure level, which if not normal may be either slightly above or below it. The characteristic effect of blood-pressure altering complications will be shown here as in normal individuals, and here as in any case, blood-pressure records are valuable in that they may early detect the onset of complicating affections, and may aid the attendant in his efforts to prevent their development.

Insanity.

Rheumatism has been singled out from the many acute infections as a condition for special blood-pressure study. The result of these studies simply shows that rheumatism, like any other acute infection, is accompanied by an elevation in pressure (10 to 20 mm.) during the period of invasion, that in severe cases it may fall to a marked hypotension, and that convalescence is marked by a gradual return to normal unless influenced by the development of complications.

Rheumatism.

The involvement of the cardiac and vasomotor centres in this obscure disease has been shown to be accompanied by an irregular effect upon the blood-

Exophthalmic Goiter. pressure; the stage of the disease and the severity of the symptoms determining the result. Thus some observers have reported an upward tendency and some a downward. The study of blood-pressure may be of value in this disease, by showing the relation of a tachycardia to a hypotension, thus directing the treatment upon more rational lines.

Menopause. The cessation of menstruation at the climacteric, while physiologic in nature, is more often than not pathologic in character, particularly that part of the phenomenon involving the nervous system. In this state, as in all profound nervous disturbances where the cardiac and vasomotor activities are involved, we have more or less frequent disturbances of vasomotor character, as shown by palpitation, tachycardia and flushings. These are often accompanied by alterations in blood-pressure, whose chief characteristic is the sudden variation in the pressure curve from normal to hypo- or hypertension and back again.

Infectious Diseases (Acute). In diphtheria, scarlet fever and infectious diseases in general, the blood-pressure shows some variation, which is mainly dependent upon the period of the disease. Thus it is found that pressure has a tendency to rise slightly (5 to 15 mm.) during the period of invasion, and then to fall gradually during the further progress of the disease to a hypotension, to rise again toward normal as convalescence is established. The occurrence of complications will be shown by a change in blood-pressure which fails to conform to this rule. Thus a complicating nephritis will be shown by an early and sharp rise in blood-pressure. This may measure more than 50 mm. in twenty-four hours.

Typhoid Fever. A slight primary rise may be noted, but this is a disease of low blood-pressure, in which the readings are not infrequently all below 100 mm. A markedly depressed blood-pressure during the attack is a valuable indication

for the need of stimulating treatment. A fall in pressure occurring suddenly, especially after the second week, is usually indicative of hemorrhage. A short, sharp rise is often a valuable sign, pointing to perforation or peritonitis from a deep ulcer.

Injections of Salvarsan and Neo-Salvarsan.

During the intravenous injections of these substances collapse not infrequently occurs without a moment's warning. It has been suggested by some observers that frequent, rapid blood-pressure tests made during this procedure would be a valuable guide as to the safe progress of the operation, and also that this test may be used as a guide to the amount and rapidity with which the drugs may be administered.

Epilepsy

Owing to the increased muscular activity occurring during an attack of apoplexy, the blood-pressure shows a rapid rise during the violent stage, and a rapid fall usually to the point of original level, as the paroxysm subsides and coma develops. In a patient seen during coma, where the patient's history cannot be obtained this fact may be of aid in differentiating the coma of epilepsy from that caused by uremia or apoplexy in which high pressure is the rule.

PATHOLOGIC CONDITIONS IN WHICH THE BLOOD-PRESSURE IS USUALLY BELOW NORMAL.

In discussing low blood-pressure we must classify several varieties of this condition in order to appreciate the underlying factors leading up to and resulting from this condition.

Terminal Hypotension.

Terminal hypotension means the gradual lowering of blood-pressure which occurs during the last hours or days of life, and is the direct result of a gradually failing cardiovascular mechanism.

Essential hypotension is met in cases in which the cause of the low pressure cannot be explained. Found occasionally in members of tuberculous families, in

Essential Hypotension. whom no definite signs of the disease are shown. It is a particularly common condition in those cases which are now occasionally recognized as having congenitally small hearts and narrow arteries.

Primary or True Hypotension. This condition is defined by Bishop as being present in those cases where the blood-pressure mechanism has failed, but where there has been no previous over-demand for pressure.

Relative Hypotension. This term is applied to the condition of blood-pressure occurring in individuals who have had a distinctively permanent elevation in blood-pressure, but in whom the pressure at the time of examination is found to be normal or slightly above. These cases are most significant, as it is in them that we meet most serious and distressing symptoms pointing to circulatory failure, yet in whom the pressure is still above the estimated normal level. This relative hypotension is sometimes hard to establish, but if once determined and satisfactorily explained, the knowledge furnishes a basis for rational treatment.

Diabetes. The blood-pressure in diabetes is low, often being found below 100 mm. The chief value of the blood-pressure test in this disease is in the detection of complications involving the kidneys. A rising blood-pressure found in the course of a case of diabetes will direct the attendant's attention to the kidneys, when a urinalysis will often explain the origin of the "turn for the worse."

Cardiac Dilatation. As would be expected, dilatation of the heart is accompanied by a dangerously low blood-pressure, which may be sufficiently low to endanger life. The finding of a low pressure in a cardiac case will plainly indicate treatment directed toward preventing syncope.

Improvement in the condition of cardiac contraction will be shown by a gradually rising pressure, accompanied by a falling pulse rate.

These are two complications which may develop under a variety of circumstances in many disease conditions.

Shock and Collapse.

In many cases which are in an apparently safe condition, the sudden development of one of these complications may result fatally. It becomes, therefore, of great importance to anticipate the onset of these complications and, upon noting the warning signs, to institute measures for their relief. This form of procedure is in many cases very successful. During surgical operations under anæsthesia, the sphygmomanometer is of great service in detecting early circulatory failure, from either heart failure or vasomotor paralysis. Many surgeons, among them Bloodgood, of Baltimore, now employ the blood-pressure test in all operations depending upon it for the continued safety of their patients.

Hemorrhage.

Closely allied to the preceding, at least in the seriousness and suddenness of its development, is hemorrhage, either external or internal. Following external hemorrhage, the blood-pressure will be found below normal, and the amount of this lowering will in a rough way indicate the amount of blood lost. This fact is true only when the observations immediately succeed the bleeding. The circulation very rapidly regains its normal equilibrium, so that, after hemorrhage of 300 to 400 c.c., causing a reduction of 30 to 40 mm., it is soon overcome and the effect as demonstrated by the sphygmomanometer lost.

Internal Hemorrhage.

In those diseases in which internal hemorrhage is a complication and after surgical operations where there is danger of secondary hemorrhage, the frequent employment of the sphygmomanometer is of greatest value in detecting this complication long before the patient is exsanguinated or in a dangerous condition.

To be of greatest value in detecting hemorrhage, the blood-pressure test should be made as often as the pulse and temperature is taken, and should be recorded on

the combined chart which is made for this purpose (see page 32). Used in this manner, a rising pulse rate and a falling blood-pressure, even when the change is slight, will direct examination along such lines as will prove or disprove the suspicion.

From the differential diagnostic standpoint the blood-pressure test, in cases where the decision rests between cerebral hemorrhage and embolism, is of greatest value, as it is well recognized that the pressure in apoplexy is always high, often above 300, while in embolism the reverse is usually the case. When a previous history is unobtainable, this test may be the one deciding factor.

Cerebral Embolism.

Blood-pressure is usually low in cases of simple catarrhal jaundice. This is probably due to the effect of absorption of intestinal products of decomposition arising from interference in digestion. It may be said that in practically all mild toxemias, particularly of gastro-intestinal origin, the tendency of blood-pressure is downward, often remaining for some time between 100 and 110.

Jaundice..

This is a disease of low pressure. The degree of lowering of pressure is a good index of the severity of the infection and the progress of the case toward recovery or otherwise. Good authority teaches that blood-pressure gradually and steadily falls in cases of progressive pulmonary tuberculosis; that it becomes stationary and tends to rise as the disease becomes arrested, and that a rising pressure means a good prognosis, as the blood-pressure practically never returns to normal in unarrested cases.

Pulmonary Tuberculosis.

The effect of high altitude on cases of pulmonary tuberculosis is to cause a rise in pressure; this rise being beneficial in that its effect is to increase the force and volume of the circulation.

An impoverished blood and a reduced physical tone, affecting all organs and tissues of the body, results in loss of vasomotor and cardiac tone,

Anemia, Chlorosis and Exhaustion States.

which is easily demonstrated by the sphygmomanometer in varying degrees of hypotension. The chief value of these studies is in directing the physician's attention to the need of absolute recumbency and rest, in order to avoid syncope from a too greatly lowered blood-pressure.

Cholera.

The great loss of fluid in cholera results in such a depression in blood-pressure that measures to combat collapse are urgently demanded. It has been demonstrated that large amounts of saline introduced either subintravenously or intravenously accomplish this rest most satisfactorily. During the transfusion the sphygmomanometer is the best guide to the effect of the procedure.

Diarrhea.

If diarrhea is profuse it will result in a lowering of blood-pressure. Under ordinary conditions this fall will be sufficient to demand special treatment, but in greatly debilitated persons, as typhoid cases after hemorrhage, the sphygmomanometer may be of great service in demonstrating a dangerously low pressure.

Effects and Danger of Hypotension.

The direct effect of a falling blood-pressure is the accumulation of an abnormal amount of blood in the veins and a slowing of the current in the arteries. This will affect the capillary circulation and interfere with the nutritive and secretory processes which depend upon it. The most serious effect is on the heart, as it has been shown that complete loss of vasomotor tone soon leads to death, because of the gradual accumulation of nearly all the blood in the body of the venous side, so that the heart has no blood upon which to act.

"Low blood-pressure due to general prostration is not to be regarded as a disorder of the circulation, except in so far as the circulation fails to respond to the demand made upon it. Thus in shock, it is the nervous system that is at fault, not the circulatory apparatus," (Bishop.)

CHAPTER V.

PREGNANCY, TOXEMIA AND ECLAMPSIA.

The obstetrician of the present day must have constant recourse to the blood-pressure test if he would maintain the lead in his profession. The sphygmomanometer now ranks with urinalysis in the examination of pregnant women. In the blood-pressure test we have a most valuable means of detecting early toxemias, which often lead to the eclamptic state. The blood-pressure test is capable of early furnishing very definite indications of departures from normal metabolism in the pregnant women.

Early Sign of Toxemia.

John Cooke Hirst (*N. Y. M. J.*, June 11, 1910) states that the earliest and most constant sign of toxemia in the latter half of pregnancy is a high and constantly rising blood-pressure, and this symptom may precede albuminuria and all other constitutional signs of an impending eclamptic attack.

Normal Pressure Readings.

Examinations of normal non-pregnant women, showing no signs of heart or kidney lesions, gave an average systolic pressure with the Faught instrument of 112 mm. He then took the pressure of 100 normal pregnant women, these showing no signs of albumin or any sign of toxemia, and found the pressure to average 118. He found that these figures held good up to approximately seven and a half months, after which date there was a gradual rise, so that in the middle of the last month of pregnancy a fairer average was 124 mm.; with subsidence of the uterus the pressure showed a slight fall. This coincides with the observations of H. C. Bailey (*S. G. and O.*, vol. xiii, No. 5, page 485), who made 1,136 systolic readings on 145 normally pregnant women in Bellevue Hospital. The average normal systolic pressure was 118 mm. He states that his readings varied greatly, but that the high limit was rarely passed. Twenty-eight per cent. showed a variation of from 25 to 30 mm. in the course

of several days. The study of the nitrogen partition of the urine of these women showed no marked changes, so that this was of very little value. In conclusion, he says that changes of less than 30 mm. above the normal average 118 means very little from a practical standpoint, and that at the onset of labor the pressure usually rises during the first and second stages of 140 and 150 mm. taken between the pains. Again another most careful observer, Hubert J. Starling (*Lancet*, Sept. 10, 1910), reports a study of blood-pressure, covering a period of five years in pregnant women in whom the normal average was from 110 to 120 mm.

All these observers are most emphatic in their statement that routine blood-pressure observations should be made a part of the periodical examination of pregnant women and that with the development of suspicious signs and advance toward the end of the gestation, the intervals between the tests should be shortened, and that the test should not be omitted during the puerperium, as in this state women may develop serious toxemia and eclamptic attacks.

Effect of Toxemia.

According to the observations of Bailey, blood-pressure in early toxemia may be low; here apparently toxic substances are circulating in the blood which have a marked influence on the vomiting centre, but little effect on the vasomotor apparatus.

In the development of toxemia in the latter months, there is usually present a blood-pressure rising principal or else a harmone action or else blood-pressure is raised to increase the natural resistance of the body. He also noted that in the fulminant type of fatal toxemia in the latter months the blood-pressure may be very low. In exceptional cases Bailey has known that convulsions may occur, and yet the blood-pressure be no higher than 155, and that eclamptic toxemia may be even more severe when the pressure is low. Thus from the analysis of blood-pressure readings made from many observers he believes that a pressure

Dangerous Pressures.

of 150 must be taken as a danger limit, and that any pressure above this demands vigorous investigation and treatment.

T. M. Green (*Boston M. and S. J.*, April 28, 1910), conveniently divides toxemia of pregnancy in three divisions:

First, moderate increase in blood-pressure.

Second, marked increase in blood-pressure.

Third, extreme increase in blood-pressure.

To these may be added the fourth which is suggested by Hirst and by Bailey, namely, *fourth*, extreme eclamptic condition in which the blood-pressure may be low.

In the first two, symptoms disappear and blood-pressure falls after delivery. In the third and fourth, blood-pressure continues abnormal and the disease usually progresses to a rapidly fatal termination.

The blood-pressure seems to bear definite relation to the type of case, and its frequent observation should be of great value both in prognosis and in treatment.

According to Hirst, the highest pressure reported by him in the toxemic case without eclampsia was 192 mm. The highest in eclampsia was 320 mm. How high he was unable to determine because the mercury ran out the top of the tube before the pulse was shut off.

CHAPTER VI.

VALUE OF BLOOD-PRESSURE IN SURGERY.

The sphygmomanometer has many applications in surgery. The safety of anesthesia is increased by the frequent application of this test during all prolonged operations. By it an impending shock is early detected, often before the usual signs develop. Thus regular and frequent tests of the blood-pressure, before, during and after operations, will serve to indicate the need for stimulation, etc.

As an indication for venesection, saline infusion or the Murphy treatment and as a guide to the beneficial effect of these several measures, the sphygmomanometer is pre-eminent.

Operations after Accidents.

The question of the safe outcome of any proposed operation frequently determines the question for or against operating on patients who have suffered accidents. This question really amounts to a determination of the degree of shock which the case has already suffered and an estimation of how much more shock the case is able to bear. This is best determined by the sphygmomanometer.

Cases in Shock.

These same considerations enter into the question of operating in extreme conditions, resulting from rapidly developing or neglected surgical conditions. The sphygmomanometer, in conjunction with the pulse, is the quickest and surest means at our command with which to arrive at the proper decision, and the blood-pressure test has undoubtedly been the means of saving many lives under the conditions mentioned above.

When to Operate.

A fair or normal blood-pressure is always a good indication of the state of the vasomotor system, because vasodilatation invariably results in hypotension, and the degree of hypotension fairly indicates the severity of shock.

An extremely rapid pulse, associated either with a

lowered blood-pressure or with one approximately normal, is an indication of a poor or shocked heart-muscle—one unlikely to withstand the strain of anesthesia.

The sphygmomanometer is often the means of determining the safe time to operate. Thus a dangerous condition of the cardiomotor and vasomotor mechanism will indicate appropriate restorative treatment, and will demonstrate plainly whether such measures are successful. The surgeon will thus be guided in his judgment as to the right time to operate.

In Anesthesia.

The blood-pressure and pulse rate immediately preceding anesthesia is usually found above normal. This is due to the excitement attending the approach of a radical procedure, and should be taken into consideration by the surgeon. This temporary disturbance in blood-pressure and pulse rate suggests the necessity of preliminary tests made, in quiet surroundings, the day before operation. This will establish the normal.

Nitrous Oxide.

During the first moments of administration of pure nitrous oxide, the blood-pressure mounts rapidly upward, the rise equaling in some cases 50 or more mm. At the same time the pulse becomes very full and strong, while the rate may remain stationary or rise slightly. Immediately succeeding the anesthesia period, the pressure rapidly falls and the pulse rate rises. This effect of nitrous oxide on blood-pressure will suggest caution in administering it to cases of arteriosclerosis or in any case where the patient's level is much above normal.

Nitrous Oxide Combined with Oxygen.

The combined administration of nitrous oxide and oxygen by one of the several apparatus now employed for this purpose is unattended by any of the alarming symptoms or rise in blood-pressure noted under nitrous oxide alone.

This combination properly administered is capable of maintaining partial or profound anesthesia, for various periods up to 45 minutes, without

materially affecting blood-pressure or pulse rate. The rise in pressure which accompanies the N_2O is entirely balanced and prevented by a proper percentage of oxygen (1 to 5 per cent.). The accompanying chart is taken from Dr. Faught's collection and well shows the result of a proper administration of the combined anesthesia.

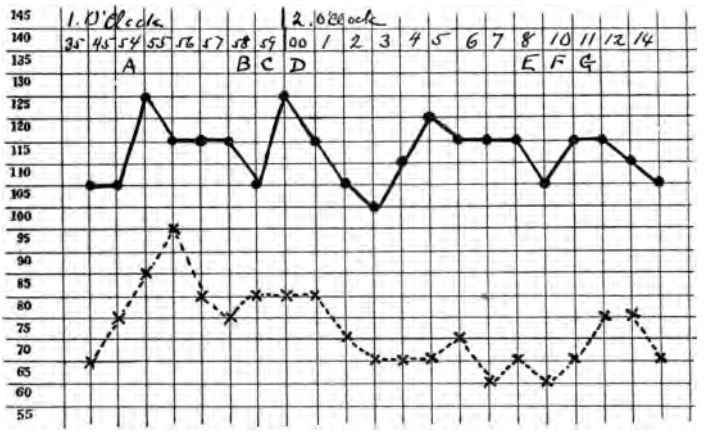


FIG. 19.—Pulse and blood-pressure chart showing effect of nitrous oxide and oxygen anesthesia. Anesthesia begun at A and ended at F.

Ether.

Ether alone causes a moderate rise in blood-pressure during the early period of its administration. Struggling causes a further rise together with an acceleration in pulse rate. These changes rapidly subside as the stage of anesthesia is reached, so that, under ordinary circumstances, the pulse and blood-pressure remain at or about the same levels on the chart as were noted prior to the removal of the case to the operating room.

Dangerous symptoms occurring during the course of operation will usually early be shown by changes in pulse rate and blood-pressure; the blood-pressure falling and the pulse rate rising, so that this change developing during anesthesia will indicate to the surgeon the advisability of haste in completing the operation or the necessity of dividing the operation into two stages.

Chloroform.

Chloroform is a dangerous anesthetic under all circumstances and its use should always be attended with great care. It has been demonstrated that blood-pressure falls gradually from the very beginning of the administration. This fall may occur during the first few minutes, and be so great as to endanger life. When this anesthetic is used, the blood-pressure test should be continuously employed, and every effort made to avoid a dangerous fall in blood-pressure.

Ethyl Chloride.

This drug, according to the last report of the anesthesia commission of A. M. A., is a very safe anesthetic, and observations on blood-pressure seem to bear this out. There is a tendency to a falling pressure, which, however, is not great, and which is easily controlled by the admission of sufficient air.

Operative Effect on Blood-pressure.

The surgeon should be in possession of the facts concerning the influence of operative procedures on blood-pressure. Thus when the skin is incised, there is usually an abrupt fall in blood-pressure, transitory in nature. The same lowering is noted when the peritoneum is incised and also when viscera are pulled upon or exposed to the drying influence of air. Two procedures, therefore, to be studiously avoided, or, if necessary, careful watch should be made for the occurrence of shock, with the sphygmomanometer, during such procedures.

CHAPTER VII.

THERAPEUTICS.

The study of blood-pressure frequently furnishes the key to proper treatment in a number of diseases; it also furnishes a reliable guide as to the efficiency of the measures employed, as well as the time during which treatment should be continued.

Hypotension.

It is not within the scope of this little work to more than touch upon a few of the most important points in the relation of blood-pressure to the management of disease.

The general symptoms accompanying diminished blood-pressure indicate in no uncertain manner the necessity of tonic treatment. In cases of emergency with suddenly falling pressure and evidence of collapse, adrenalin intravenously or hypodermically is indicated.

For the sudden drop in blood-pressure occurring in advanced arteriosclerosis, digitalis is indicated, provided there is no evidence of marked myocardial degeneration, in which event strychnin is the safer drug to use.

In lowered blood-pressure from hemorrhage or profuse and prolonged diarrhea the pressure is the best indicator of the amount and the frequency for the use of saline infusion or the Murphy treatment.

Albumen appears in the urine whenever the kidneys are passively congested, and its importance, when due to this cause, is often greatly exaggerated. Albuminuria associated with kidney disease is nearly always accompanied with elevation in blood pressure; albumen when due to other causes is not usually so accompanied. As these two causes of albuminuria demand almost diametrically opposite treatment, their differentiation is of the utmost importance.

Albuminuria.

High pressure in the apoplectically inclined calls for active and continued pressure-reducing treatment. Among the drugs which are generally depended upon to accomplish this

Hypertension.

change are the nitrites, of which a freshly prepared solution of sodium nitrite will be found the most serviceable, being easy of administration and prolonged in action.

In the treatment of aortic aneurysm with high pressure, the use of blood-pressure reducing agents may materially prolong life by reducing the tendency to rupture and at the same time afford relief from the most distressing symptom—pain—by lessening the tension in the aneurysmal sac, thereby relieving the nerve irritation and the pressure upon surrounding organs or tissues.

In acute Bright's, after failing to reduce the pressure by the usual measures, it may sometimes be controlled by the electric-light sweat bath. In one case a reduction of from 20 to 40 millimeters was obtained, the beneficial effects lasting for many hours, so that regular observation of the pressure determined the proper interval between the sweats.

When to Treat High Blood-pressure.

Before taking up the question of remedies employed for the treatment of elevated blood-pressure, it is important to realize that the mere finding of an elevated blood-pressure is not always an indication that it should be reduced; it is always a bad rule to promiscuously institute measures to reduce pressure. This should never be done. Blood-pressure reduction should only be attempted for a good reason, based upon a careful study of the case. Long-continued high pressure often becomes an essential to the well-being of the individual, which, if interfered with, may so destroy the circulatory equilibrium that disaster results. The chief group of drugs employed to control and lower high blood-pressure are the vasodilators. These act chiefly upon the sympathetic and vasomotor systems, cause a widening of the blood channels and a consequent lowering of the blood-pressure. The value of the sphygmomanometer is chiefly in demonstrating the efficiency of the measures employed in any given case. This guards the practitioner from placing too much confidence in any particular remedy

because he can readily ascertain whether he is accomplishing the desired result. This is particularly important because numerous investigators have shown that no particular drug can be depended upon to produce the same results under all conditions, even with a maximum dose. Another important function of the sphygmomanometer in therapeutics is to determine the period of duration and action of the particular drug employed, thereby enabling the physician to intelligently manage his therapeutic measures and accomplish his purpose. The sphygmomanometer has also shown that many measures other than drugs may be relied upon to control and lower high blood-pressure, often more advantageously. Thus in the employment of vapor baths of various sorts we can control the effect and determine the proper time for another treatment.

Efficiency of Measures Demonstrated.

In venesection the amount of blood which may safely be withdrawn is best determined by noting the effect of the bleeding on blood-pressure.

BLOOD-PRESSURE IN LIFE INSURANCE.

During the last three years, a majority of life insurance companies have admitted the value of the blood-pressure test as a diagnostic aid in life insurance examinations. At the present time, some of the larger companies require the test of every applicant for life insurance. A larger number require the test of all applicants over forty years, in overweights and underweights, and in all those in whom the character of the risk has been previously questioned by any company.

Importance of Blood-pressure Test.

The chief value of this test lies in the fact, that by a study of these records in conjunction with the pulse, we are able to detect beginning pathologic change in the cardio-vascular system or kidneys, often before there are any definite signs in the physical examination, personal history or urine. Another good reason for the

universal employment of the blood-pressure test in life insurance examinations is the fact that the apparent character of the pulse and of the vessel walls does not always convey the correct information regarding the condition of the applicant. Clinicians have agreed that the estimation of blood-pressure by palpation is not satisfactory and that even the most experienced occasionally fall into grave error.

Normal or Permissible Variation.

Unlike the temperature, which has a fixed normal, the blood-pressure in the normal individual is a variable factor. This is because of the complicated cardiomotor and vasomotor mechanisms. These are under sympathetic control and are therefore affected by the varying conditions to which the body is subjected during every twenty-four hours. These variations result from changes in posture, exercise, excitement, and from digestive activity. They are also dependent upon the time of day, age, sex, and the physical development of the individual. Fortunately, the amount of alteration in pressure caused by these varying conditions is not great, and we are therefore able to lay down a fairly definite rule which has for its object the determination of the permissible variation in pressure in any individual of a given age. The writer devised and published, in 1910, a formula which may be used to estimate the normal systolic blood-pressure, which gives results conforming closely with the figures obtained from careful clinical reports. The formula is as follows: "Consider the normal average systolic blood-pressure in men at age twenty to be 120 mm. Then add 1 mm. for every additional two years of life." Thus a man aged thirty should have a normal average systolic blood-pressure of 125 mm., while a man aged sixty should average 140 mm. The difference in pressure between men and women is approximately 10 mm., being lower in women.

Formula to Estimate Normal Pressure.

Clinical evidence shows that the ordinary daily variations in pressure in any individual rarely amount

Permissible Variations. to more than 36 mm. If we accept this, then a variation of 17 either above or below the normal average may be allowed.

As a routine measure the left arm should be employed and the cuff should be applied to the bare arm. The applicant should be in a comfortable position, preferably sitting. Time should be allowed to permit the circulation to become quieted and nervous individuals should be assured of the harmlessness of the test.

Application of Test.

A single reading equal to or just above the estimated maximum pressure for a given individual should never be accepted as final, as this pressure may be accidental and may never again be met. Observations should be repeated at a later time or upon a different day before reporting the pressure.

A modern degree of arteriosclerosis may cause an elevation in pressure but slightly above the estimated high normal; 15 or 20 mm. above this calls for further investigation not only of the blood-pressure, but of the general physical condition of the applicant.

Arteriosclerosis.

The blood-pressure will frequently read between 160 and 180 mm. in the average case of uncomplicated arteriosclerosis.

Urinalysis does not always demonstrate chronic nephritis, particularly in individuals of apparent normal health. On the other hand, it is said that the blood-pressure in an established case of chronic interstitial nephritis is rarely below 200 mm. In acute nephritis, the blood-pressure, while above the normal, may not be that high. The finding of a high blood-pressure with a normal urine calls for repeated urinalysis.

Nephritis.

The finding of a trace of albumen and a few hyaline casts in the urine, with a normal blood-pressure, suggests the probability that the urinary condition is not the result of kidney alteration, but is metabolic in char-

Metabolic Albuminuria.

acter. Such a condition can readily be relieved by appropriate treatment while the case is held under advisement, and many of them will eventually obtain the amount of insurance desired.

This group shows an unfavorable mortality in life insurance statistics, particularly of the older ages.

Overweights. Given an individual of modern overweight, where the physical examination and history are favorable, the final decision is often made upon the result of the blood-pressure test; accepting them when the pressure is normal and declining them when the pressure reaches or passes the normal high limit.

This is the most difficult condition to diagnose, especially by the insurance examiner, because these cases often require long study and careful observation in order to arrive at the proper rating. A history of hard physical labor, excessive brain work, alcoholism or syphilis is often significant. In the early cases the systolic pressure is not always altered, so that recourse must be had to the functional tests of Graupner and Shapiro (see page 45), and also to the estimation of the diastolic and pulse pressures.

Chronic Myocarditis.

Slight reduction in blood-pressure, combined with modern elevation in pulse rate, even without fever, suggests the possibility of an active pulmonary lesion. If this be combined with fever and a history of slight loss in weight, the case should be declined on this presumptive evidence. In tuberculosis the blood-pressure is usually low and the pulse pressure diminished.

Incipient Tuberculosis.

ARM-BANDS.

The experience of a large number of observers covering the whole range of sphygmomanometry has settled the question for all time, that a rubber armlet of less than four inches (11 cm.) in width is inaccurate except when applied to a greatly emaciated arm or when used on children.

The Pilling Co. now manufactures four styles of armlets or pressure cuffs which are intended to meet the various demands of different sphygmomanometers.

FIG. 20.

Figure 20 illustrates the arm-band used with the Faught Standard Mercury Sphygmomanometer. This is a rigid reinforced leather cuff, 5 by 16 inches, attached to the arm by means of leather straps with friction buckles. This covers a rubber compression bag measuring 4¾ inches by 13 inches.

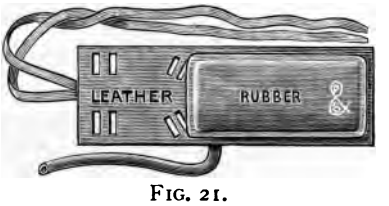


FIG. 21.

Figure 21 illustrates the arm-band used on the Pilling Special Mercury Sphygmomanometer. The cuff is of leather reinforced, attached to the arm by means of leather straps with friction buckles. The leather portion measuring 7 by 15 inches, and has attached to its inner surface a cloth-covered pure-rubber compression bag, measuring 5 by 9 inches.

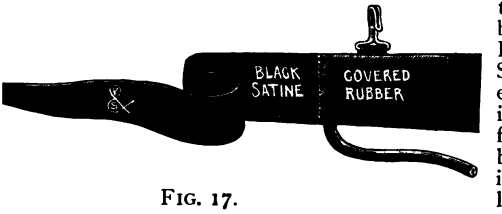


FIG. 17.

Figure 17 illustrates the arm-band used on the Faught Pocket Sphygmomanometer. This cuff is made in the form of a roller bandage containing between its layers an easily removable rubber bag measuring 5 by 9 inches. The supporting material is soft and durable and measures 5¼ inches at its widest part, tapering to 2 inches. Length 40 inches. Color gray.

CHILDREN'S ARM-BAND.

The child's size arm-band is not illustrated, but is similar in construction to that employed with the pocket instrument (Fig. 17), only it is approximately half the width; the rubber bag measuring 3 by 8 inches.

KEY OF FAUGHT APPARATUS ATTACHED TO FEDDE INDICATOR.

For Technique see pages 28 to 30.

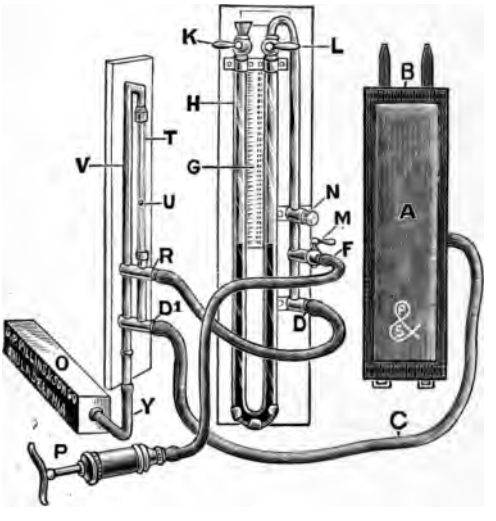


FIG. 23.

Fig. 23 shows key to letters used in explanation of all illustrations.

A. Armlet—rubber.
B. Armlet—leather.
C. Armlet—connection.
D. Nipple for armlet.
D1. Nipple for armlet.
E. Hand bellows.
F. Nipple for pressure.
G. Scale.
H. Manometer tube.
I. Link brace.
K. Guard cock.
L. Guard cock.
M. Pressure guard cock.
N. Exhaust valve.
O. Pneumatic chamber.
P. Pump.
R. Union nipple.
T. Osscillometer tube.
U. Osscillator.
V. Vertical connection.
W. Mercury reservoir.
Y. Flexible connection.

DILATATION OF CERVIX UTERI.

The accompanying illustration shows an ingenious device suggested by Dr. B. C. Hirst, of the University of Pennsylvania, in which he employs the Faught Standard Sphygmomanometer as a means of measuring the amount of pressure developed within the bag employed for dilatation of the cervix uteri. This permits of a much more accurate measure of pressure than when the simple hand bulb is used.

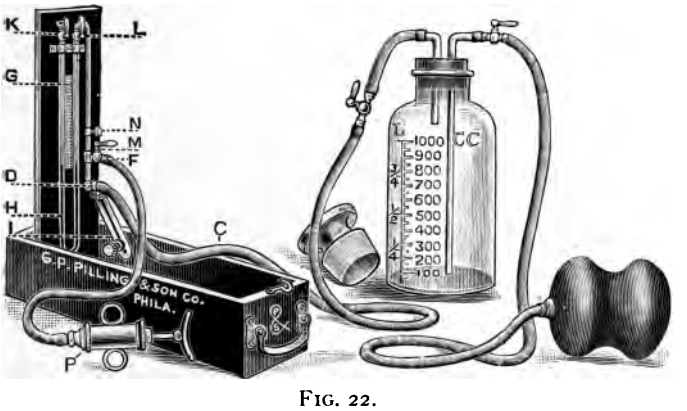


FIG. 22.

As in the illustration shown, the sphygmomanometer is connected with the large bottle (which is similar to the bottle used with Daland-Faught Test Meal Apparatus) containing water, into which dips the tube connecting with the dilatation bag; therefore, any pressure produced in the bottle will force the fluid into the bag and the sphygmomanometer at the same time registers in mm. Hg. the pressure exerted.

TO PRODUCE HYPEREMIA.

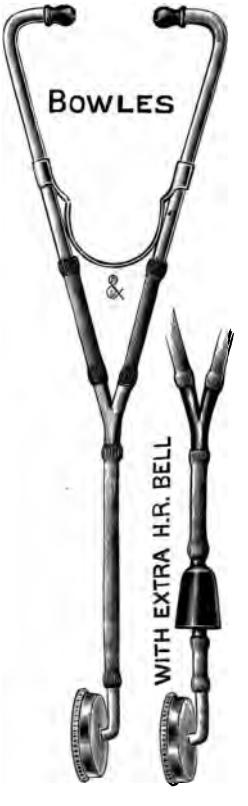
It has been suggested that the armlet of the sphygmomanometer may be employed to develop hyperemia, for therapeutic purposes, in the extremities, and reports seem to show that this method is successful.

AS A TOURNIQUET.

The arm-band may also be used as a tourniquet, both to arrest hemorrhage in an extremity and as a means of dilating veins for the introduction of Salvarsan or other intravenous treatment. In cases of accident to the extremities in which hemorrhage is a factor, the arm-band and pump will furnish a most efficient first-

device.

THE BOWLES STETHOSCOPE



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G. P. PILLING & SON [illegible]

SOLE LICENSEES

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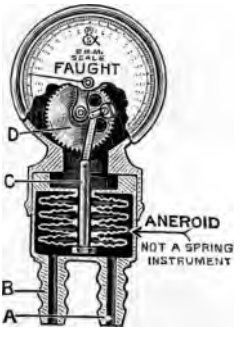
FAUGHT POCKET SPHYGMOMANOMETER

ACTUAL SIZE

FAUGHT POCKET ANEROID INSTRUMENT

Complete in genuine leather case, with Faught Certificate

$22.50 Net



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MADE ONLY BY

G. P. PILLING & SON CO.

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FAUGHT CLINICAL POCKET SPHYGMOMANOMETER

FAUGHT CLINICAL POCKET SPHYGMOMANOMETER

Complete in genuine leather case, with Faught Certificate

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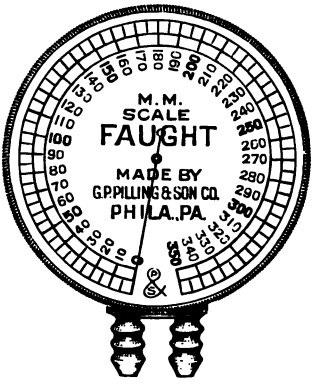


½ ACTUAL SIZE

Gives accurate readings up to 350 mm. Hg. Maintains the same degree of efficiency and accuracy as the other Faught-Pilling Sphygmomanometers.

"This instrument will be found particularly valuable in the consulting room, and in the hospitals where it is desired to demonstrate the readings before groups of physicians, students, or nurses."

FOR SALE BY ALL SURGICAL DEALERS

MADE ONLY BY

G. P. PILLING & SON CO.

PHILADELPHIA, U. S. A.

THE FAUGHT SPHYGMOMANOMETER

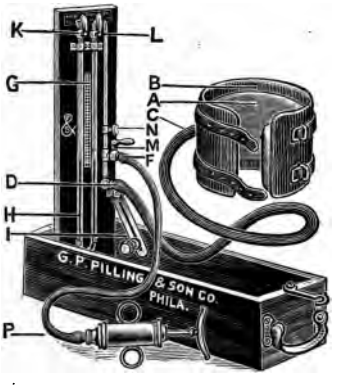
Accurately Standardized

Simple, Compact, Durable, Easy to Use

Always ready to use; time required for the observation reduced to a minimum; no preliminary adjustment of the apparatus required; mercury cannot be spilled; no detachable parts to be lost.

An Invaluable Aid in Diagnosis, Prognosis and Treatment

Indispensable to the General Practitioner, the Internal Specialist, the Surgeon, the Oculist, the Laryngologist, the Otologist, the Gynecologist, the Obstetrician and the Student of Medicine.



The FAUGHT SPHYGMOMANOMETER embodies the essentials of the earlier instruments while omitting unnecessary complexity in construction. Thus eliminating the objectionable features and reducing to a minimum the time required for observations.

For Sale by All Surgical Instrument Dealers

Complete, with Arm-band and Metal Pump in Mahogany Case, with Signed Certificate of Dr. Faught.

Price, $20.00 Net.

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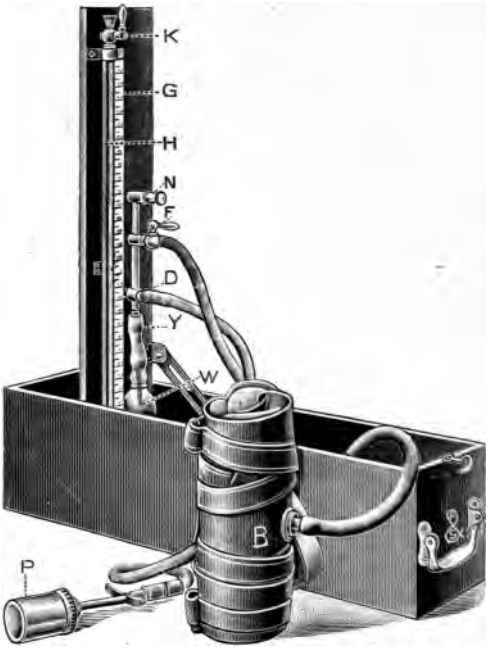
Pilling Special Faught Patent
SPHYGMOMANOMETER



In order to meet the demand for a cheaper model of the Faught mercury instrument, the Pilling Special has been devised. This instrument embodies the salient features of the Faught Standard Sphygmomanometer, and will be found serviceable, accurate and reliable.

PILLING SPECIAL MADE IN TWO GRADES

No. 1—With stiff arm-band, highly finished metal parts and with mahogany case, 3 x 3¾ x 14½ in., with Faught Certificate, *$15.00 Net.*

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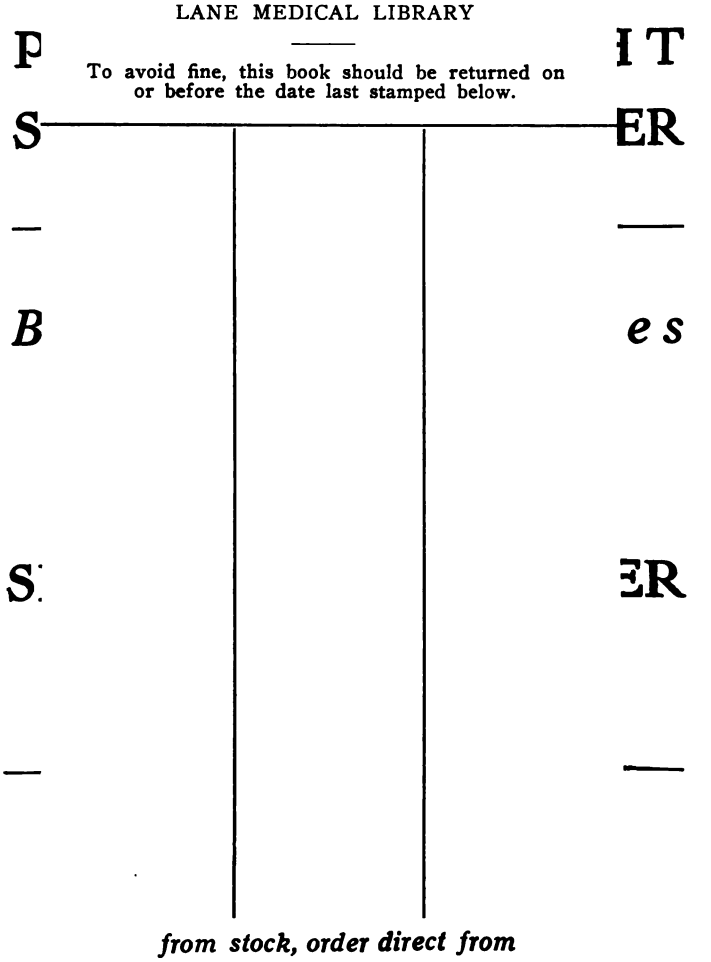

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